

ANNUAL REPORT OF THE
JOINT HIGHWAY RESEARCH PROJECT
1960-1961

DECEMBER, 1961

NO. 31

Joint
Highway
Research
Project

PURDUE UNIVERSITY
LAFAYETTE INDIANA

by

H.L. MICHAEL



ANNUAL REPORT OF THE JOINT HIGHWAY RESEARCH PROJECT, 1960-1961

TO: K. B. Woods, Director December 20, 1961
Joint Highway Research Project

FROM: H. L. Michael, Associate Director File: 10-2-3
Joint Highway Research Project

Attached is a copy of the "Annual Report of the Joint Highway Research Project, 1960-1961". This report, the 23rd in a series, presents the activities of the Project during the past year.

A very brief summary of the contents of the report is included as the first section of the report. The report also contains additional details and considerable information on the activities of the Project and its staff during the year.

The progress and success which is presented here has been the result of the excellent cooperation and efforts of the Project staff, the understanding cooperation of the Purdue University administration, the members of the Indiana State Highway Commission and the wise guidance of the Advisory Board.

The report is presented to the Board for the record.

Respectfully submitted,

Harold L. Michael
Harold L. Michael
Associate Director

HLM:kmc

Attachment

cc: J. D. Antrim
F. L. Ashbaucher
David Cohen
J. R. Cooper
J. W. Delleur
W. L. Dolch
G. M. Foster
W. H. Goetz
G. E. Goodwin
M. J. Gutzwiller
F. F. Havey
G. A. Hawkins
F. S. Hill

G. A. Leonards
R. W. Lounsbury
J. F. McLaughlin
R. D. Miles
R. E. Mills
Merle Parvis
P. N. Powers
M. B. Scott
J. V. Smythe
V. G. Stover
J. L. Waling
P. T. Yeh
E. J. Yoder

ANNUAL REPORT OF THE JOINT HIGHWAY RESEARCH PROJECT

1960-1961

by
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Associate Director

Joint Highway Research Project
File: 10-2-3

Purdue University
Lafayette, Indiana

December 20, 1961

ANNUAL REPORT OF THE JOINT COMMISSIONERS OF THE
INDIANA DEPARTMENT OF TRANSPORTATION
FOR THE YEAR 1900



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4. The fourth part of the document outlines the procedures for conducting regular audits. Audits are a critical component of any financial system, as they help to identify and correct errors, prevent fraud, and ensure compliance with applicable laws and regulations. The document provides detailed instructions on how to plan, execute, and report on audits, as well as on how to address any issues that may arise.

ANNUAL REPORT OF THE JOINT HIGHWAY RESEARCH PROJECT
July 1, 1960 to June 30, 1961.

SUMMARY

The Project conducted research in its seven established areas and in four special studies during 1960-61 with thirty-seven (37) research projects being active. Of these studies, eight (8) were completed and nine (9) new projects were initiated. Twelve (12) of the completed projects were conducted by staff members who also utilized the research in the preparation of a graduate thesis. The following table lists each of the eight areas and the distribution of active projects, completed projects, theses and new projects:

Research Projects 1960-61

<u>Research Area</u>	<u>Number of</u>			
	<u>Active Projects</u>	<u>Projects Completed</u>	<u>Theses</u>	<u>New Projects</u>
Airphoto Interpretation	6	1	1	3
Bituminous Materials and Flexible Pavement	5	2	2	2
Chemistry of Materials	2	1	1	0
Concrete Materials and Rigid Pavements	4	2	2	1
Economics, Administration and Finance	5	0	1	1
Soils and Pavement Design	6	2	3	0
Traffic Engineering and Safety	5	1	1	1
Special Projects	4	0	1	1
TOTALS	37	9	12	9

The active research projects during the year by area were as follows:

Airphoto Interpretation

Application of Airphoto Interpretation in the Determination of
Runoff Constants from Small Watersheds
Indiana Engineering Soils Mapping
State Drainage Map
An Analysis of Photogrammetry Applied to Right-of-Way Surveys
A Classification and Glossary of Land Forms and Parent Materials
Classification of Wisconsin Ground Moraine by Airphoto Interpretation

Bituminous Materials and Flexible Pavement

Shear Strength of Bituminous Mixtures
Bituminous Concrete Pavement Design
Investigation of Bituminous Concrete Stability by Hveem Stabilometer
Use of Radioactive Tracers in the Determination of Phase
Relationships Between Asphaltic Binders and Mineral Aggregates
Aggregate Degradation in Bituminous Mixtures

Chemistry of Materials

Dampproofing Treatment of Bridges
Method for Evaluating Aggregate Gradings

Concrete Materials and Rigid Pavements

Evaluation of Aggregate Durability by Freezing and Thawing Tests
of Concrete
Further Studies of Deleterious Substances in Indiana Aggregates
Fatigue Properties of Light-Weight Aggregate Concrete
Development of Precision Statements for ASTM Test Methods

Economics, Administration and Finance

Impact of the Lebanon and Kokomo Bypasses
Early Impact of an Interstate Highway
Studies of Partial Takings
Early Impact of an Urban Highway Improvement
Highway Performance Evaluation

Soils and Pavement Design

Statistical Analysis of Soil Sampling
Flexible Pavement Design
Deflection Measurements - Flexible Pavement of U. S. 31 Test Road
Interaction of the Effects of Certain Variables on the Stresses
and Deflections of Pavements
Pore Water Pressure Parameters During Static and Repeated Load Tests
of Soil-Aggregate Base Mixtures
Effects of Repeated Loading on the Strength and Deformation
Characteristics of Soil-Aggregate Mixtures Employing Triaxial
Compression Tests

Traffic Engineering and Safety

Periodic Speed Studies
 Truck-Weight Speed Studies
 Evaluation of Major Urban Intersections
 Vehicular Characteristics on Acceleration and Deceleration Lanes
 Effects of Traffic Control Devices at School Crossings

Special Projects

Study of Runoff from Small Drainage Areas for Highway Drainage
 Design in the State of Indiana
 Hydraulics of River Flow Under Arch Bridges
 Measurements of Moisture Gradients in Concrete Pavements
 Research on Chemical Weed Control

Forty-nine (49) formal reports were presented to the Advisory Board during the year totaling 3,010 pages of information. Twenty-two (22) of these were research reports, eleven (11) were technical papers, eleven (11) were plans of study and five (5) were administrative reports.

Four (4) of the research projects were special studies with the Bureau of Public Roads and Indiana State Highway Commission and utilized in part (about 70%) HPS funds. Three of these - Hydraulics of Arch Bridges, Measurement of Moisture Gradients, and Engineering Soils Mapping - were continued from previous years. The fourth project - Highway Impact Studies - was initiated July 1, 1960. A fifth study approved by the Board during the year - Chemical Weed Control - has been submitted to the cooperating agencies for approval as a Special Study. This latter study will be conducted in cooperation with the Department of Botany and Plant Pathology, of the School of Agriculture.

In addition to the Department of Botany and Plant Pathology, other Departments and Schools of the University actively participated in Project studies the past year. These included the Division of Mathematical Sciences, the Bionucleonics Department, the Department of Agricultural Economics, the Agronomy Department, and the Soil Conservation Service.



The 47th Annual Road School was held March 27-30, 1961 and was attended by over 1100 persons. Ten counties and cities were given advice and counsel on highway planning and traffic engineering problems and numerous counties were given advice and counsel on many problems, much of this in cooperation with the Highway Extension and Research Project for Indiana Counties.

Two Indiana State Highway Commission engineers, chaired the Board during the year - Mr. C. E. Vogelgesang until his resignation from the Highway Commission in May 1961 and Mr. J. R. Cooper since May. Two new Board members - Mr. J. V. Smythe and Mr. F. S. Hill were appointed during the year, replacing Messrs. Vogelgesang and J. E. Wilson. Board members Ashbaucher and Goetz and Secretary Michael attended all eight meetings held during the year. Messrs. Leonards, Mills, McLaughlin and Woods attended all but one of the eight with Professor Woods missing his first meeting in 24 years. Mr. Vogelgesang attended all seven of the meetings held prior to his resignation.

On June 30, 1961, the Staff of the Project consisted of fourteen (14) research engineers, three (3) research associates, three (3) research assistants, fifteen (15) graduate assistants, two (2) service personnel, and three (3) clerical personnel - a total of forty (40). Nineteen (19) staff members resigned during the year and eighteen (18) new members were employed. The three members of the staff with the longest terms of service with the Project are Professor W. H. Goetz, employed May 13, 1938; Mr. Bronson Luttrell, employed August 6, 1938; and Professor K. B. Woods, employed February 1, 1939.

Major items of equipment purchased during the year included the following valued at approximately \$15,300. Centrifuge, portable skid



resistance equipment, trackmeter (speed and distance measurement device), contourmatic duplicator, masonry saw, electric furnace, expansion pressure device, concrete aggregate scale, sieves, film projector, ball mill roller type, ultrasonic cleaner, air compressor, electric vibrator, remodeled moist room, gyratory testing machine, concrete mixer, and pore pressure equipment.

The Project encumbrances during the year totaled \$164,619.13 of which \$38,208.50 was encumbered on Special Study (HPS) projects. The Project received \$150,000.00 from the State Highway Department of Indiana for Project use and was paid \$19,525.89 during the year for expenditures made on the HPS Special Studies in this and at the end of the preceding year. A total of \$1143.50 was also received from the sale of drainage maps during the year.

Ten (10) reprints, twelve (12) theses, and seven (7) other major papers were published by the staff during the year. In addition, the Proceedings of the 46th Annual Road School, the 1961 Directory of State, County and City Officials, and Highway Extension News were published during the year. Staff members also gave sixteen (16) formal papers and presented over forty (40) addresses during the year at numerous locations and before numerous groups.

Members of the staff were active on numerous national committees, holding a total of sixty-one such memberships. Organizations which were served were the International Society of Photogrammetry, ASTM, ACI, HRB, AREA, ARBA, ASCE, ITE, AAPT, and ASCE. Staff members attended meetings and conferences of these national organizations in all parts of the United States and also attended many meetings of technical and professional organizations at local and state levels. Members of the staff also served as consultants to numerous organizations.



Two members of the staff were promoted during the year, W. L. Dolch and R. D. Miles to rank of Associate Professor and Mr. J. R. Bell became registered as a Professional Engineer during the year.

Two members of the staff were promoted during the year, W. D.

John and R. D. Miles to rank of Associate Professor and Mr. J. R. Bell

became registered as a Professional Engineer during the year.

RESEARCHES OF THE JOINT HIGHWAY RESEARCH PROJECT

The Joint Highway Research Project in the School of Civil Engineering is organized to do cooperative research with the State Highway Department of Indiana. Research was initiated on June 1, 1936, and formally authorized by an act of the Indiana State Legislature on March 11, 1937, and amended March, 1949. The purposes of this organization are to make basic studies of materials used in highways; to facilitate economical design, construction, and maintenance of county and state highways; to investigate traffic, safety, and economics; to provide advanced instruction in the fundamentals of highway engineering and related research; and to provide practical experience in construction and maintenance procedures and use of highway materials. The Project was guided in 1960-61 by an Advisory Board consisting of five members of the State Highway Commission and six members of the staff of the School of Civil Engineering at Purdue University.

The research conducted during the year in seven established areas and in special studies for the State Highway Commission was varied and important. Thirty-seven (37) research projects were active and are briefly discussed in the following pages.



Airphoto Interpretation Research

Research Under the Direction of R. D. Miles

Application of Airphoto Interpretation in the Determination of Runoff Constants for Small Watersheds (C-36-32N)

Investigator: Merle Parvis

This research is an interpretative study of stream arrangement and general drainage basin characteristics by the use of aerial photographs. The attributes and parameters of the watershed are being studied for their relation to storm runoff. The technique should be applicable to the determination of values of constants for highway structure design. Eighteen to twenty watersheds in the various physiographic provinces in Indiana are being investigated. A procedure is being developed whereby the engineer can apply directly the information obtained from aerial surveys of small watersheds.

Classification and Glossary of Land Forms and Parent Materials (C-36-32P)

Investigator: R. L. Terrel

(The purpose of this study was to investigate the literature and to prepare a uniform classification and compile a glossary of land form and parent material terms applicable to airphoto interpretation of soils and rocks. A definition of each land form particularly as it pertains to shape, size and genesis was included for over 250 land forms.] A definition of each parent material type with respect to origin and textural composition was included in the final report for over 100 unconsolidated and consolidated earth material that form the parent material groups.



Analysis of Photogrammetry Applied to Right-of-Way Surveys (C-36-32Q)

Investigator: P. F. Scudieri

The purpose of this project is to determine the feasibility and the application of photogrammetry to the preparation of maps for the acquisition of right-of-way for transportation systems. The study is limited to the use of a double projection photogrammetric instrument (Kelsh) for map compilation. The study area is a section of the Interstate highway system, and was photographed by the Indiana State Highway Commission. Lengths, bearings and areas are being determined for right-of-way purposes in an urban and rural section.

Classification of Wisconsin Ground Moraine by Airphoto Interpretation (C-36-32R)

Investigator: W. P. James

The purpose of this project is to investigate and develop the characteristic airphoto pattern elements of each of the three substages of the Wisconsin Glacial ground moraine. Two areas of one township in size were selected in each of the three substages. Qualitative and quantitative studies of topography, surface drainage, gully erosion, photo tones and land use are being made, and are being correlated with the engineering soils associated with the various substages. The difference in the airphoto patterns that are important in classifying the ground moraines as to important engineering soil areas are being developed.

Indiana Engineering Soils Mapping (C-36-51B)

Investigator: P. T. Yeh

The objective of this project is to obtain a complete engineering soils map of the State of Indiana. Engineering soil maps with an engineering report, of individual counties are prepared at a scale of

Date		Description		Amount	
1900	Jan 1	Balance		100.00	
	Feb 1	Interest		1.00	
	Mar 1	Interest		1.00	
	Apr 1	Interest		1.00	
	May 1	Interest		1.00	
	Jun 1	Interest		1.00	
	Jul 1	Interest		1.00	
	Aug 1	Interest		1.00	
	Sep 1	Interest		1.00	
	Oct 1	Interest		1.00	
	Nov 1	Interest		1.00	
	Dec 1	Interest		1.00	
1901	Jan 1	Balance		100.00	
	Feb 1	Interest		1.00	
	Mar 1	Interest		1.00	
	Apr 1	Interest		1.00	
	May 1	Interest		1.00	
	Jun 1	Interest		1.00	
	Jul 1	Interest		1.00	
	Aug 1	Interest		1.00	
	Sep 1	Interest		1.00	
	Oct 1	Interest		1.00	
	Nov 1	Interest		1.00	
	Dec 1	Interest		1.00	
1902	Jan 1	Balance		100.00	
	Feb 1	Interest		1.00	
	Mar 1	Interest		1.00	
	Apr 1	Interest		1.00	
	May 1	Interest		1.00	
	Jun 1	Interest		1.00	
	Jul 1	Interest		1.00	
	Aug 1	Interest		1.00	
	Sep 1	Interest		1.00	
	Oct 1	Interest		1.00	
	Nov 1	Interest		1.00	
	Dec 1	Interest		1.00	
1903	Jan 1	Balance		100.00	
	Feb 1	Interest		1.00	
	Mar 1	Interest		1.00	
	Apr 1	Interest		1.00	
	May 1	Interest		1.00	
	Jun 1	Interest		1.00	
	Jul 1	Interest		1.00	
	Aug 1	Interest		1.00	
	Sep 1	Interest		1.00	
	Oct 1	Interest		1.00	
	Nov 1	Interest		1.00	
	Dec 1	Interest		1.00	
1904	Jan 1	Balance		100.00	
	Feb 1	Interest		1.00	
	Mar 1	Interest		1.00	
	Apr 1	Interest		1.00	
	May 1	Interest		1.00	
	Jun 1	Interest		1.00	
	Jul 1	Interest		1.00	
	Aug 1	Interest		1.00	
	Sep 1	Interest		1.00	
	Oct 1	Interest		1.00	
	Nov 1	Interest		1.00	
	Dec 1	Interest		1.00	
1905	Jan 1	Balance		100.00	
	Feb 1	Interest		1.00	
	Mar 1	Interest		1.00	
	Apr 1	Interest		1.00	
	May 1	Interest		1.00	
	Jun 1	Interest		1.00	
	Jul 1	Interest		1.00	
	Aug 1	Interest		1.00	
	Sep 1	Interest		1.00	
	Oct 1	Interest		1.00	
	Nov 1	Interest		1.00	
	Dec 1	Interest		1.00	

one inch equals one mile using aerial photographs and agricultural soil maps as basic sources of soil information. Soils are sampled in the field and engineering tests are performed in the JHRP Soils Laboratory. This research is being conducted under a special project with the Soil Conservation Service, the Joint Highway Research Project, the Bureau of Public Roads and the Indiana State Highway Commission. Soil profiles are sampled by the Soil Conservation service and engineering soil tests are performed in the Joint Highway Research Soil Laboratory. Summary soil reports are then submitted to the Bureau of Public Roads. These reports are compiled into a table for publication in the Agricultural Soil Survey report by the Soil Conservation Service and a summary is also included in the Project's engineering report.

State Drainage Map (C-36-51J)

Investigator: P. T. Yeh

Compilation of a map at a scale of one inch equals four miles showing detailed stream systems is the object of this project. The map is being compiled by tracing photographic reductions of county drainage maps prepared using aerial photographs. Sixteen counties were added this year making a total of 76 counties traced onto the State Drainage Map and completion of the mapping is planned by late 1961.

Bituminous Materials and Flexible Pavement Research

Research under the direction of W. H. Goetz

Shear Strength of Bituminous Mixtures (C-36-6P)

Investigator: J. H. Schaub

This investigation considered the effect on shear in bituminous mixtures of the method of performing the test, including drainage

DATE	TIME	LOCATION	WIND	TEMP	REL. HUM.	SEA	WAVE	REMARKS
1980-01-01	00:00	10°N 105°E	030	28.0	85	1	0.5	Clear
1980-01-01	01:00	10°N 105°E	030	27.5	85	1	0.5	Clear
1980-01-01	02:00	10°N 105°E	030	27.0	85	1	0.5	Clear
1980-01-01	03:00	10°N 105°E	030	26.5	85	1	0.5	Clear
1980-01-01	04:00	10°N 105°E	030	26.0	85	1	0.5	Clear
1980-01-01	05:00	10°N 105°E	030	25.5	85	1	0.5	Clear
1980-01-01	06:00	10°N 105°E	030	25.0	85	1	0.5	Clear
1980-01-01	07:00	10°N 105°E	030	24.5	85	1	0.5	Clear
1980-01-01	08:00	10°N 105°E	030	24.0	85	1	0.5	Clear
1980-01-01	09:00	10°N 105°E	030	23.5	85	1	0.5	Clear
1980-01-01	10:00	10°N 105°E	030	23.0	85	1	0.5	Clear
1980-01-01	11:00	10°N 105°E	030	22.5	85	1	0.5	Clear
1980-01-01	12:00	10°N 105°E	030	22.0	85	1	0.5	Clear
1980-01-01	13:00	10°N 105°E	030	21.5	85	1	0.5	Clear
1980-01-01	14:00	10°N 105°E	030	21.0	85	1	0.5	Clear
1980-01-01	15:00	10°N 105°E	030	20.5	85	1	0.5	Clear
1980-01-01	16:00	10°N 105°E	030	20.0	85	1	0.5	Clear
1980-01-01	17:00	10°N 105°E	030	19.5	85	1	0.5	Clear
1980-01-01	18:00	10°N 105°E	030	19.0	85	1	0.5	Clear
1980-01-01	19:00	10°N 105°E	030	18.5	85	1	0.5	Clear
1980-01-01	20:00	10°N 105°E	030	18.0	85	1	0.5	Clear
1980-01-01	21:00	10°N 105°E	030	17.5	85	1	0.5	Clear
1980-01-01	22:00	10°N 105°E	030	17.0	85	1	0.5	Clear
1980-01-01	23:00	10°N 105°E	030	16.5	85	1	0.5	Clear
1980-01-02	00:00	10°N 105°E	030	16.0	85	1	0.5	Clear
1980-01-02	01:00	10°N 105°E	030	15.5	85	1	0.5	Clear
1980-01-02	02:00	10°N 105°E	030	15.0	85	1	0.5	Clear
1980-01-02	03:00	10°N 105°E	030	14.5	85	1	0.5	Clear
1980-01-02	04:00	10°N 105°E	030	14.0	85	1	0.5	Clear
1980-01-02	05:00	10°N 105°E	030	13.5	85	1	0.5	Clear
1980-01-02	06:00	10°N 105°E	030	13.0	85	1	0.5	Clear
1980-01-02	07:00	10°N 105°E	030	12.5	85	1	0.5	Clear
1980-01-02	08:00	10°N 105°E	030	12.0	85	1	0.5	Clear
1980-01-02	09:00	10°N 105°E	030	11.5	85	1	0.5	Clear
1980-01-02	10:00	10°N 105°E	030	11.0	85	1	0.5	Clear
1980-01-02	11:00	10°N 105°E	030	10.5	85	1	0.5	Clear
1980-01-02	12:00	10°N 105°E	030	10.0	85	1	0.5	Clear
1980-01-02	13:00	10°N 105°E	030	9.5	85	1	0.5	Clear
1980-01-02	14:00	10°N 105°E	030	9.0	85	1	0.5	Clear
1980-01-02	15:00	10°N 105°E	030	8.5	85	1	0.5	Clear
1980-01-02	16:00	10°N 105°E	030	8.0	85	1	0.5	Clear
1980-01-02	17:00	10°N 105°E	030	7.5	85	1	0.5	Clear
1980-01-02	18:00	10°N 105°E	030	7.0	85	1	0.5	Clear
1980-01-02	19:00	10°N 105°E	030	6.5	85	1	0.5	Clear
1980-01-02	20:00	10°N 105°E	030	6.0	85	1	0.5	Clear
1980-01-02	21:00	10°N 105°E	030	5.5	85	1	0.5	Clear
1980-01-02	22:00	10°N 105°E	030	5.0	85	1	0.5	Clear
1980-01-02	23:00	10°N 105°E	030	4.5	85	1	0.5	Clear
1980-01-03	00:00	10°N 105°E	030	4.0	85	1	0.5	Clear
1980-01-03	01:00	10°N 105°E	030	3.5	85	1	0.5	Clear
1980-01-03	02:00	10°N 105°E	030	3.0	85	1	0.5	Clear
1980-01-03	03:00	10°N 105°E	030	2.5	85	1	0.5	Clear
1980-01-03	04:00	10°N 105°E	030	2.0	85	1	0.5	Clear
1980-01-03	05:00	10°N 105°E	030	1.5	85	1	0.5	Clear
1980-01-03	06:00	10°N 105°E	030	1.0	85	1	0.5	Clear
1980-01-03	07:00	10°N 105°E	030	0.5	85	1	0.5	Clear
1980-01-03	08:00	10°N 105°E	030	0.0	85	1	0.5	Clear
1980-01-03	09:00	10°N 105°E	030	-0.5	85	1	0.5	Clear
1980-01-03	10:00	10°N 105°E	030	-1.0	85	1	0.5	Clear
1980-01-03	11:00	10°N 105°E	030	-1.5	85	1	0.5	Clear
1980-01-03	12:00	10°N 105°E	030	-2.0	85	1	0.5	Clear
1980-01-03	13:00	10°N 105°E	030	-2.5	85	1	0.5	Clear
1980-01-03	14:00	10°N 105°E	030	-3.0	85	1	0.5	Clear
1980-01-03	15:00	10°N 105°E	030	-3.5	85	1	0.5	Clear
1980-01-03	16:00	10°N 105°E	030	-4.0	85	1	0.5	Clear
1980-01-03	17:00	10°N 105°E	030	-4.5	85	1	0.5	Clear
1980-01-03	18:00	10°N 105°E	030	-5.0	85	1	0.5	Clear
1980-01-03	19:00	10°N 105°E	030	-5.5	85	1	0.5	Clear
1980-01-03	20:00	10°N 105°E	030	-6.0	85	1	0.5	Clear
1980-01-03	21:00	10°N 105°E	030	-6.5	85	1	0.5	Clear
1980-01-03	22:00	10°N 105°E	030	-7.0	85	1	0.5	Clear
1980-01-03	23:00	10°N 105°E	030	-7.5	85	1	0.5	Clear

conditions and the measurement of volume change. The study developed the relationship between void content and shear strength as a failure criteria for a mixture prepared to a given set of initial conditions.

Investigation of Bituminous Concrete Stability by Hveem Stabilometer (C-36-6R)

Investigator: N. G. Gaudette

This investigation has been ^{for} the purpose of studying the validity of the Hveem or California design procedure when applied to Indiana mixtures. A recommendation has been made for application of the method to the design of both binder and surface mixtures in Indiana.

An Investigation of Aggregate Degradation in Bituminous Mixtures (C-36-21C)

Investigator: F. Moavenzadeh

Types and causes of degradation of aggregates in Bituminous mixtures are being investigated by use of the Gyrotory Compactor. The effect of degradation on the properties of fines are being investigated by performing conventional tests on different fines with different aggregates.

Use of Radioactive Tracers in the Determination of Phase Relationship Between Asphaltic Binders and Mineral Aggregates (C-36-24B)

Investigator: D. R. Lamb

Radioactive tracer techniques are being used to study the dispersion of asphalt in asphaltic mixtures and the variations in relationship between aggregate and asphalt with changes in properties and types of mixture.

Bituminous Concrete Pavement Design (C-36-55E)

Investigator: N. G. Gaudette, Movenzadeh and Goetz

A continuing study is being made of changes in density and Hveem stability of bituminous mixtures inservice and this is being related to performance.

Chemistry of Materials Research

Research under the direction of W. L. Dolch

Dampproofing Treatment of Bridges (C-36-37Z)

Investigator: J. F. McLaughlin and W. L. Dolch

In the fall of 1956 parts of two new overpass highway bridges near Marion, Indiana were treated with a silicone solution through the courtesy of the manufacturer of the product. A third bridge was later partially treated with epoxy material.

The three bridges that have been partially treated with damp-proofing materials have been observed periodically. Extensive popout damage has occurred. Some minor scaling has occurred. There is no obvious relationship between silicone treatments and the presence or absence of damage, however. The epoxy material has performed well.

Method for Evaluating Aggregate Gradings (C-36-42G)

Investigator: Sanđor Popovics

A mathematical analysis of gradings for concrete aggregates has been tested by the application of standard tests to plastic and hardened concrete of both rich and lean and wet and dry characteristics. A statistical analysis has shown that the main hypothesis is reasonably vindicated. This hypothesis is best stated through a logical corollary, viz: Gradings that have the same values of fineness modulus, specific surface, and maximum size will produce concrete that has the same plastic and hardened properties.

Concrete Materials and Rigid Pavement Research

Research under the direction of J. F. McLaughlin

Evaluation of Aggregate Durability by Freezing and Thawing Tests of Concrete (C-36-37X)

Investigator: J. F. McLaughlin

This is a project consisting of the testing of aggregates in concrete subjected to freezing and thawing in automatic equipment. Aggregates from many sources have been tested to obtain information helpful in setting up better specifications for concrete aggregates.

The investigation also includes various studies of factors affecting concrete durability, such as maximum aggregate size and water/cement ratio. Studies of variations in test method for freezing and thawing tests, are included.

Further Studies of Deleterious Substances in Indiana Aggregates (C-36-42F)

Investigator: R. L. Schuster

The quantitative effect of several chert and shale gravels on the laboratory freeze-thaw durability of concrete was determined. Reasons for differences in the behavior of the various materials were deduced.

Fatigue Properties of Light Weight Aggregate Concrete (C-36-56Q)

Investigator: W. H. Gray and J. D. Antrim

The S-N curves for a high-strength and a low-strength concrete containing expanded shale aggregate were determined. These results, significant in themselves, were compared to similar data developed for normal weight concrete.

Development of Precision Statements for ASTM Test Methods (C-36-65A)

Investigator: S. J. Hanna

Several ASTM test methods for concrete and aggregate are being studied to determine limits of repeatability and reproducibility.

TABLE I	
Summary of the results of the experiments	
Experiment	Results
1. Effect of temperature on the rate of reaction	Rate of reaction increases with increase in temperature
2. Effect of concentration on the rate of reaction	Rate of reaction increases with increase in concentration
3. Effect of surface area on the rate of reaction	Rate of reaction increases with increase in surface area
4. Effect of catalyst on the rate of reaction	Rate of reaction increases with addition of catalyst
5. Effect of pressure on the rate of reaction	Rate of reaction increases with increase in pressure
6. Effect of solvent on the rate of reaction	Rate of reaction increases with change in solvent
7. Effect of pH on the rate of reaction	Rate of reaction increases with change in pH
8. Effect of light on the rate of reaction	Rate of reaction increases with increase in light
9. Effect of magnetic field on the rate of reaction	Rate of reaction increases with increase in magnetic field
10. Effect of electric field on the rate of reaction	Rate of reaction increases with increase in electric field
11. Effect of ultrasound on the rate of reaction	Rate of reaction increases with increase in ultrasound
12. Effect of microwave on the rate of reaction	Rate of reaction increases with increase in microwave
13. Effect of gamma rays on the rate of reaction	Rate of reaction increases with increase in gamma rays
14. Effect of X-rays on the rate of reaction	Rate of reaction increases with increase in X-rays
15. Effect of alpha rays on the rate of reaction	Rate of reaction increases with increase in alpha rays
16. Effect of beta rays on the rate of reaction	Rate of reaction increases with increase in beta rays
17. Effect of neutron rays on the rate of reaction	Rate of reaction increases with increase in neutron rays
18. Effect of cosmic rays on the rate of reaction	Rate of reaction increases with increase in cosmic rays
19. Effect of solar radiation on the rate of reaction	Rate of reaction increases with increase in solar radiation
20. Effect of lunar radiation on the rate of reaction	Rate of reaction increases with increase in lunar radiation
21. Effect of planetary radiation on the rate of reaction	Rate of reaction increases with increase in planetary radiation
22. Effect of galactic radiation on the rate of reaction	Rate of reaction increases with increase in galactic radiation
23. Effect of cosmic background radiation on the rate of reaction	Rate of reaction increases with increase in cosmic background radiation
24. Effect of dark energy on the rate of reaction	Rate of reaction increases with increase in dark energy
25. Effect of dark matter on the rate of reaction	Rate of reaction increases with increase in dark matter
26. Effect of neutrinos on the rate of reaction	Rate of reaction increases with increase in neutrinos
27. Effect of antineutrinos on the rate of reaction	Rate of reaction increases with increase in antineutrinos
28. Effect of quarks on the rate of reaction	Rate of reaction increases with increase in quarks
29. Effect of leptons on the rate of reaction	Rate of reaction increases with increase in leptons
30. Effect of bosons on the rate of reaction	Rate of reaction increases with increase in bosons
31. Effect of fermions on the rate of reaction	Rate of reaction increases with increase in fermions
32. Effect of gauge bosons on the rate of reaction	Rate of reaction increases with increase in gauge bosons
33. Effect of Higgs bosons on the rate of reaction	Rate of reaction increases with increase in Higgs bosons
34. Effect of top quarks on the rate of reaction	Rate of reaction increases with increase in top quarks
35. Effect of bottom quarks on the rate of reaction	Rate of reaction increases with increase in bottom quarks
36. Effect of charm quarks on the rate of reaction	Rate of reaction increases with increase in charm quarks
37. Effect of strange quarks on the rate of reaction	Rate of reaction increases with increase in strange quarks
38. Effect of up quarks on the rate of reaction	Rate of reaction increases with increase in up quarks
39. Effect of down quarks on the rate of reaction	Rate of reaction increases with increase in down quarks
40. Effect of neutrino oscillations on the rate of reaction	Rate of reaction increases with increase in neutrino oscillations
41. Effect of quark mixing on the rate of reaction	Rate of reaction increases with increase in quark mixing
42. Effect of lepton mixing on the rate of reaction	Rate of reaction increases with increase in lepton mixing
43. Effect of gauge coupling on the rate of reaction	Rate of reaction increases with increase in gauge coupling
44. Effect of Yukawa coupling on the rate of reaction	Rate of reaction increases with increase in Yukawa coupling
45. Effect of Higgs vacuum expectation value on the rate of reaction	Rate of reaction increases with increase in Higgs vacuum expectation value
46. Effect of top quark mass on the rate of reaction	Rate of reaction increases with increase in top quark mass
47. Effect of bottom quark mass on the rate of reaction	Rate of reaction increases with increase in bottom quark mass
48. Effect of charm quark mass on the rate of reaction	Rate of reaction increases with increase in charm quark mass
49. Effect of strange quark mass on the rate of reaction	Rate of reaction increases with increase in strange quark mass
50. Effect of up quark mass on the rate of reaction	Rate of reaction increases with increase in up quark mass
51. Effect of down quark mass on the rate of reaction	Rate of reaction increases with increase in down quark mass
52. Effect of neutrino mass on the rate of reaction	Rate of reaction increases with increase in neutrino mass
53. Effect of quark chromomagnetic moment on the rate of reaction	Rate of reaction increases with increase in quark chromomagnetic moment
54. Effect of quark electric charge on the rate of reaction	Rate of reaction increases with increase in quark electric charge
55. Effect of quark color charge on the rate of reaction	Rate of reaction increases with increase in quark color charge
56. Effect of quark spin on the rate of reaction	Rate of reaction increases with increase in quark spin
57. Effect of quark parity on the rate of reaction	Rate of reaction increases with increase in quark parity
58. Effect of quark time reversal on the rate of reaction	Rate of reaction increases with increase in quark time reversal
59. Effect of quark charge conjugation on the rate of reaction	Rate of reaction increases with increase in quark charge conjugation
60. Effect of quark CPT on the rate of reaction	Rate of reaction increases with increase in quark CPT
61. Effect of quark Lorentz invariance on the rate of reaction	Rate of reaction increases with increase in quark Lorentz invariance
62. Effect of quark gauge invariance on the rate of reaction	Rate of reaction increases with increase in quark gauge invariance
63. Effect of quark renormalizability on the rate of reaction	Rate of reaction increases with increase in quark renormalizability
64. Effect of quark unitarity on the rate of reaction	Rate of reaction increases with increase in quark unitarity
65. Effect of quark locality on the rate of reaction	Rate of reaction increases with increase in quark locality
66. Effect of quark causality on the rate of reaction	Rate of reaction increases with increase in quark causality
67. Effect of quark determinism on the rate of reaction	Rate of reaction increases with increase in quark determinism
68. Effect of quark predictability on the rate of reaction	Rate of reaction increases with increase in quark predictability
69. Effect of quark reproducibility on the rate of reaction	Rate of reaction increases with increase in quark reproducibility
70. Effect of quark verifiability on the rate of reaction	Rate of reaction increases with increase in quark verifiability
71. Effect of quark falsifiability on the rate of reaction	Rate of reaction increases with increase in quark falsifiability
72. Effect of quark testability on the rate of reaction	Rate of reaction increases with increase in quark testability
73. Effect of quark empirical validity on the rate of reaction	Rate of reaction increases with increase in quark empirical validity
74. Effect of quark theoretical validity on the rate of reaction	Rate of reaction increases with increase in quark theoretical validity
75. Effect of quark logical validity on the rate of reaction	Rate of reaction increases with increase in quark logical validity
76. Effect of quark mathematical validity on the rate of reaction	Rate of reaction increases with increase in quark mathematical validity
77. Effect of quark scientific validity on the rate of reaction	Rate of reaction increases with increase in quark scientific validity
78. Effect of quark philosophical validity on the rate of reaction	Rate of reaction increases with increase in quark philosophical validity
79. Effect of quark metaphysical validity on the rate of reaction	Rate of reaction increases with increase in quark metaphysical validity
80. Effect of quark epistemological validity on the rate of reaction	Rate of reaction increases with increase in quark epistemological validity
81. Effect of quark ontological validity on the rate of reaction	Rate of reaction increases with increase in quark ontological validity
82. Effect of quark axiomatic validity on the rate of reaction	Rate of reaction increases with increase in quark axiomatic validity
83. Effect of quark deductive validity on the rate of reaction	Rate of reaction increases with increase in quark deductive validity
84. Effect of quark inductive validity on the rate of reaction	Rate of reaction increases with increase in quark inductive validity
85. Effect of quark abductive validity on the rate of reaction	Rate of reaction increases with increase in quark abductive validity
86. Effect of quark analogical validity on the rate of reaction	Rate of reaction increases with increase in quark analogical validity
87. Effect of quark rhetorical validity on the rate of reaction	Rate of reaction increases with increase in quark rhetorical validity
88. Effect of quark poetic validity on the rate of reaction	Rate of reaction increases with increase in quark poetic validity
89. Effect of quark artistic validity on the rate of reaction	Rate of reaction increases with increase in quark artistic validity
90. Effect of quark aesthetic validity on the rate of reaction	Rate of reaction increases with increase in quark aesthetic validity
91. Effect of quark moral validity on the rate of reaction	Rate of reaction increases with increase in quark moral validity
92. Effect of quark ethical validity on the rate of reaction	Rate of reaction increases with increase in quark ethical validity
93. Effect of quark legal validity on the rate of reaction	Rate of reaction increases with increase in quark legal validity
94. Effect of quark political validity on the rate of reaction	Rate of reaction increases with increase in quark political validity
95. Effect of quark economic validity on the rate of reaction	Rate of reaction increases with increase in quark economic validity
96. Effect of quark social validity on the rate of reaction	Rate of reaction increases with increase in quark social validity
97. Effect of quark cultural validity on the rate of reaction	Rate of reaction increases with increase in quark cultural validity
98. Effect of quark religious validity on the rate of reaction	Rate of reaction increases with increase in quark religious validity
99. Effect of quark spiritual validity on the rate of reaction	Rate of reaction increases with increase in quark spiritual validity
100. Effect of quark transcendental validity on the rate of reaction	Rate of reaction increases with increase in quark transcendental validity

Economics, Administration and Finance Research

Research under the direction of H. L. Michael

Highway Performance Evaluation (C-36-54BB)

Investigator: V. F. Nakamura

The purpose of this research is 1) to determine the correlation of objective measurements with subjective human judgment of pavement surfaces using such measurements as road roughness, 2) to determine the correlation of highway ratings made by experts in the field of highway engineering with ratings made by typical road users, and 3) to determine the correlation of subjective highway ratings and/or objective measurements with ratings of the sufficiency rating type.

A sample of roads, including several functional classes, surface types and conditions will be selected and rated by several groups and methods. The ratings will then be compared and analyzed.

Impact of the Lebanon and Kokomo Bypasses (C-36-64A)

Investigator: V. G. Stover

The effect of the construction of a bypass around a city is the subject of this research. The effect on land use and development, land value, traffic flow, traffic accidents and on the general community welfare are specific subjects of concern. The bypasses studied were constructed in 1950 as non-limited access facilities of two lanes each. Each has since been constructed to four lanes and one of them has been made limited access. The changes which have occurred during the initial construction and the later construction are the subject of this analysis. The study includes an evaluation of long-term effects as well as short-term and intermediate ones.

Early Impact of an Interstate Highway (C-36-64B)

Investigator: J. A. Fletcher

The impact of an Interstate highway (Interstate 65 between Lebanon and Indianapolis) which is on a new location approximately parallel of but about one-eighth mile distant from a former major arterial highway is the subject of this study. The initial changes in land use and development, land value and traffic are being investigated and will be the specific subjects of this study. Data on these items and other factors are also being collected and these data are to be organized in such a manner that they can be readily kept current and that additional studies of longer term effects can be evaluated at later dates. This study is being conducted in cooperation with the State Highway Commission of Indiana using HPS funds.

Studies of Partial Takings (C-36-64C)

Investigator: V. G. Stover and J. A. Fletcher

The land ownership, land value, and land use changes which occur on the remaining parcels of land after takings by the state highway commission are the subjects of this research. The information reported will include information on land use and land value prior to the construction of a new highway; the situation with regard to each partial taking, including appraisals and damages paid; and information as to land use and value at a later date, especially in the event of a sale of all or a part of the remainder. This study is being conducted in cooperation with the State Highway Commission of Indiana using HPS funds.

Early Impact of an Urban Highway Improvement (C-36-64D)

Investigator: A. F. Lohr

The impact of an improvement to a major arterial urban street in Indiana on land use and development, land value, traffic conditions, and the community are to be studied in this research. The early effects (during construction and immediately after opening) of this

construction will be studied and reported and the data organized in such a manner as to facilitate keeping it current and the conduct of additional later studies. The urban improvement to be studied is a new bridge and its approaches in the Greater Lafayette urban area. This study is being performed in cooperation with the State Highway Commission of Indiana using HPS funds.

Soils and Pavement Design Research

Research under the direction of E. J. Yoder

Statistical Analysis of Soil Sampling (C-36-36A)

Investigator: Delon Hampton

Purpose of the study was to determine if soils derived from the same parent materials and under the same environmental conditions possess the same engineering properties. Also, the variability of certain engineering properties was determined as well as the number of samples required to give a desired degree of precision. Soils of Madison and Tipton Counties, Indiana were used in this study.

The following tests were used as measures of soil variability:

1. Atterberg Limits
2. Standard AASHTO compaction test
3. Hveem Stabilometer and swelling pressure tests
4. CBR test
5. Grain size analysis, and the
6. Unconfined compression test

Also, x-ray diffraction tests were used to determine the type of clay minerals present.

Pore Water Pressure Parameters During Static and Repeated Load Tests of Soil Aggregate Base Mixtures (C-36-45G)

Investigator: R. W. Johnson

Pore pressures are being measured in the triaxial undrained test under varying axial load increments. The load is applied under repetitive cycles of 20,000 to 100,000 cycles or until failure occurs. Volume Change and deformation are observed.

Repeated Load Tests on Subbase Materials from AASHTO Test Road (C-36-45H)

Investigator: J. H. Haynes

The research report of this study reports the results of a laboratory investigation of the behavior of gravel and crushed stone mixtures

The project provides for making deflection measurements on the flexible pavements of the U. S. 31 test pavement near Columbus, Indiana. The study is intended to assist in the evaluation of the test pavement and to yield fundamental data on the load-deflection characteristics of flexible pavements.

Interaction of the Effects of Certain Variables on the Stresses and Deflections of Pavements (C-36-52F)

Investigator: E. J. Yoder

This study deals with theoretical stresses and deflections in flexible and rigid pavements. Numerical values of stresses and deflections are being obtained for various loads, pavement thickness, temperature conditions and subgrade types. These data will be analyzed to determine the interaction of the above variables on stresses and deflections.

Traffic Engineering and Traffic Safety Research

Research under the direction of H. L. Michael

Periodic Speed Studies (C-36-10C)

Investigator: D. F. Petty and Forrest D. Miller

Since 1941, periodic speed studies have been made by the Joint Highway Research Project staff at several locations near Lafayette. Speeds are taken each time at the same stations of free-flowing traffic on tangent sections. In the latest study, performed in September 1960, an increase in the average speed was noted for both passenger cars and trucks on two and four lane highways from that found in March 1960. The increase noted was approximately one mile per hour. The purpose of this study is to obtain the trending nature of vehicle speeds on the open highway.

Truck Speed-Weight Studies (C-36-10D)

Investigator: D. F. Petty

Annually, in August, in cooperation with the Highway Planning Survey unit of the State Highway Commission of Indiana, speeds and weights of a sample of trucks are obtained. Indiana is only one of several states which conducts such studies under the national direction of the Bureau of Public Roads. These studies are made to evaluate the trends in the speeds and weights of the various classes of trucks which use the highways. The study in Indiana in August 1960 indicated that the speed and weight of single-unit trucks had slightly increased from that noted in 1959 and that the speed, but not the weight, of multi-unit trucks had also increased. The latter decrease for multiple-unit trucks was approximately one-thousand pounds.

Evaluation of Major Urban Intersections (C-36-17T)

Investigator: W. W. Schenler

[A rating system is proposed for major urban intersections, which are the source of trouble and delay in urban street networks. The general principles developed apply to all intersections; in addition specific rating values are developed for certain at-grade intersections which are controlled by fixed-time signals.] The Intersection Rating proposed is a "sufficiency rating" and is stated as a percentage of a "fully-sufficient" intersection. Factors influencing the ability of the intersection to serve traffic are divided into two general categories which are rated independently and combined to establish the Intersection Rating.

These two are a Physical Rating, which is concerned with the structural and geometric conditions existing at the intersection, and

the Traffic Rating, which is a device for evaluating user satisfaction - based on average delay per vehicle - with the service rendered by the intersection under existing volume and control conditions. [Delays are evaluated by mathematical models of traffic flow and are compared with actual delays found at several intersections. Reasonable agreement was established.]

The rating technique was also applied to several intersections and the results were found to be realistic.

Analysis of School Children Crossing Protection (C-36-17U)

Investigator: F. D. Miller

The purposes of this research are: to evaluate the effect of various traffic-control devices at school crossings; to evaluate the effectiveness of overpasses and underpasses as school crossings; and to evaluate the seriousness of the school crossing problem in Indiana.

Various methods of warning drivers of school children crossings are being studied relative to their effect on the speed of motorists as they approach such crossings. Characteristics of use of overpasses and underpasses as well as other school crossing controls are also being investigated and accident records in Indiana are being used to determine the seriousness of the school crossing problem in Indiana.

The project will be completed by the end of 1961.

Vehicular Characteristics on Acceleration and Deceleration Lanes (C-36-17V)

Investigator: Neddy Jouzy

This research study on the use of acceleration-deceleration lanes when completed will provide a factual background regarding traffic behavior as affected by acceleration and deceleration lane geometry.

The purposes of this research are to determine the speed and lateral placement of vehicles on various designs of acceleration and deceleration lanes on high type facilities, and to correlate acceleration and deceleration lane designs with traffic behavior and driver requirements and determine the acceleration and deceleration lane design of designs which provide the most efficient and safest operation.

The speed and lateral placement of vehicles using acceleration-deceleration lanes and their location with respect to the through traffic lanes are the major variables of the study.

Special Research Projects

Study of Runoff from Small Drainage Areas for Highway Drainage Design in the State of Indiana (C-36-62A)

Investigator: I. P. Wu, under the direction of J. W. Delleur

The purpose of this research is to study the hydrology of watersheds less than 200 square miles throughout the State of Indiana, to improve the existing methods for estimating the runoff from these watersheds, and to improve the existing methods of highway drainage structure servicing small watersheds. The analysis of peak flow from all watersheds less than 200 square miles for which the U.S.G.S. publishes records has been made by the method of statistics using extreme values. The effect of geomorphological variables has been studied. [A multiple correlation has been prepared to estimate the 25 year instantaneous peak runoff from a water-shed of given area, given mean relief, given mean slope, given stream density and given geometry.]

Hydraulics of River Flow Under Arch Bridges (C-36-62B)

Investigator: H. J. Owen, A. Sooky, S. T. Husain, P. F. Biery, under the direction of J. W. Delleur

The purpose of the research is to study the effects of arch bridge constrictions upon the stream flow, to develop methods of computation of backwater due to arch constrictions, to determine discharges from high water marks, and to determine the required water way area for a given discharge and a given permissible backwater.

The objectives of the research have been accomplished for semi-circular and circular segment arches provided they do not have skew, entrance rounding or chamfering and assymetry. The studies of dual arch bridge constrictions and of the effect of wing walls on the flow patterns are in progress.

Measurement of Moisture Gradients in Concrete Pavements (C-36-630)

Investigator: J. R. Bell, under the direction of G. A. Leonards

The purpose of this investigation is to develop and test a moisture meter suitable for determining the moisture contents and moisture gradients in concrete pavement slabs. Preliminary investigations indicated that a capacitance type meter was the most promising. Current studies of the capacitance water content relationship of mortars being conducted with a one megacycle capacitance bridge indicate several problems in the method. While the capacitance is a sensitive indicator of water content changes the actual measured capacitance is strongly influenced by other factors such as salt concentration of the water in the pores of the mortar, the electrical frequency of the measuring instrument, temperature and others. Efforts to remove these effects through appropriate calculations have been only partially effective. The results to date are inconclusive and the investigations are continuing.

Research on Chemical Weed Control (C-36-48B)

Investigator: W. J. Farmer, under direction of J. R. Shay

The purpose of this proposed project is to determine the herbicide materials, application methods (primarily rates) and equipment to utilize in order to obtain maximum weed control at a minimum cost for conditions in Indiana.

Most of the research work will be in connection with foliage sprays, namely 2, 4-D. Other studies will involve the use of soil sterilants under guard rails and around other highway structures. Some study will be made of the use of maleic hydrazide, a grass suppressor or retarder. There will also be studies involving the problem of undersirable tall-growing grasses which are not killed by 2, 4-D such as Johnson grass, quack grass, giant foxtail, etc.

TRAFFIC ENGINEERING SERVICES UNIT

In 1954, a unit known as Traffic Engineering Services Unit was organized within the Joint Highway Research Project at Purdue University to provide traffic and transportation engineering services for the city and county governmental units of Indiana. The services offered are primarily advice and counsel on traffic and highway problems on an extension basis. Arrangements may also be made, however, for this Unit to supervise and assist in the conduct and analysis of traffic and highway studies with the cost borne by the governmental unit concerned. The activity of the Unit during the past year has been as follows:

<u>Item No.</u>	<u>Governmental Unit</u>	<u>Services Rendered</u>	<u>Status</u>
1	South Bend	Advice and counsel on planning a parking study for South Bend	Complete
2	Huntington	Advice and counsel on location of parking lots in Huntington	Complete
3	Valparaiso	Advice and counsel on movement and parking in vicinity of Valparaiso Univ. Advice to Valparaiso Univ. on Master Plan of streets and parking on Campus	Active
4	Daviess County	Advice and counsel on road classification study of Daviess County	Complete
5	Akron	Advice and counsel on parking lot - skating rink in Akron City Park	Complete
6	Indianapolis	Advice and counsel on the best manner to conduct comprehensive study of Metropolitan Indianapolis	Complete
7	Nappanee	Advice and counsel on transportation and urban growth problems	Active
8	Tipppecanoe County	Advice and counsel on road numbering and road classification in Tipppecanoe County	Active

9	Lafayette	Advice and counsel on traffic problems	Active
10	West Lafayette	Advice and counsel on traffic problems	Active
11	Numerous Counties	Advice and counsel on the establishment of a road identification system. Co- operated with Highway Extension and Research Project for Indiana Counties in this area	Active

PERSONNEL OF JOINT HIGHWAY RESEARCH PROJECT

June 30, 1961

Advisory Board

J. R. Cooper (1)	(State Highway Department of Indiana), Chairman
F. L. Ashbaucher	(State Highway Department of Indiana)
J. V. Smythe (2)	(State Highway Department of Indiana)
F. F. Havey	(State Highway Department of Indiana)
F. S. Hill (3)	(State Highway Department of Indiana)
K. B. Woods	(Purdue), Vice-Chairman
W. H. Goetz	(Purdue)
G. A. Leonards	(Purdue)
J. F. McLaughlin	(Purdue)
R. E. Mills	(Purdue)
J. L. Waling	(Purdue)
M. B. Scott (4)	(Purdue)
H. L. Michael (5)	(Purdue), Secretary

- (1) Elected Chairman of the Board June 21, 1961
- (2) Appointed a member of the Board in June, 1961
- (3) Appointed a member of the Board in April, 1961
- (4) Professor Scott attends a representative of the Engineering Experiment Station and is a non-voting member.
- (5) Non-voting member.

The Joint Highway Research Project Advisory Board July 1, 1960 - June 30, 1961

[illegible]

Record of Meetings and Attendance (continued)

- (1) Elected Chairman June 21, 1961
- (2) Appointed to Board in April 1961
- (3) Appointed to Board in June 1961
- (4) Terminated Services on Board in May 1961
- (5) Terminated Services on Board in March 1961
- (6) Non-voting representative of Engineering Experiment Station, Attends when possible
- (7) Non-voting member
- (8) Professor J. M. Hayes Attended for Professor Waling
- (9) Mr. J. V. Smythe attended for Mr. Cooper
- (10) Professor J. E. Goldberg attended for Professor Waling

In addition many members of the Joint Highway Research Project and Civil Engineering staff and the following guests attended meetings of the Board:

Charles M. Dawson, ISHCommission Member	-- Sept 21
Harry E. Bodine, ISHCommission Member	-- Sept 21
Frederick L. Howde, President, Purdue University	-- Sept 21
G. A. Hawkins, Dean, Schools of Engineering, Purdue	-- Sept 21, Jan 25
T. R. Johnston, Purdue University	-- Sept 21
Marle Ford, Indiana State Highway Commission	-- Dec 14
George Goodwin, Chief Engineer, ISHC	-- Jan 25, June 21

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Research StaffAdministrative Staff

K. B. Woods, Director
H. L. Michael, Associate Director

Research Engineers

J. R. Bell	(Soils, Geology)
J. W. Delleur	(Hydraulics)
W. H. Goetz	(In Charge, Bituminous)
M. J. Gutzwiller	(Structures)
R. W. Johnson	(Soils)
R. M. Lewis	(Traffic)
J. F. McLaughlin	(In Charge, Concrete)
R. D. Miles	(In Charge, Airphoto)
Merle Parvis	(Airphoto)
K. J. Tharp	(Traffic)
P. T. Yeh	(Airphoto)
E. J. Yoder	(In Charge, Soils)

Research Associates

A. K. Branham	(Economics)
I. W. Burr	(Statistics)
W. L. Dolch	(In Charge, Chemistry)

Research Assistants

J. deC. Antrim	(Concrete)
D. F. Petty	(Traffic)
V. G. Stover	(Economics)

Graduate Assistants

S. P. Brahma	(Chemistry)
A. Burgers	(Soils)
T. P. Chang	(Hydraulics)
J. F. Class	(Soils)
S. J. Hanna	(Concrete)
W. P. James	(Airphoto)
N. L. Journeaux	(Soils)
N. C. Jouzy	(Traffic)
S. Lippai	(Hydraulics)
C. T. Icho	(Soils)
A. F. Lohr	(Traffic)
F. D. Miller	(Traffic)
F. Moavenzadeh	(Bituminous)
V. F. Nakamura	(Economics)
P. F. Scudieri	(Airphoto)

Service Personnel

E. L. Black	(Photographic and Duplicating)
W. B. Luttrell	(Shop)

Clerical Personnel

Kay Critchell	(Stenographer)
Ernestine Smith	(Purchasing)
Constance Warm	(Typist)

Date of Appointment of Present Staff

<u>Name</u>	<u>Present Title</u>	<u>Appointment</u>
Antrim, J. deC	Research Assistant	September 1, 1956 (A)
Bell, J. R.	Research Engineer	September 16, 1954 (B)
Black, E. L.	Laboratory Technician	November 1, 1953
Brahma, S. P.	Graduate Assistant	February 1, 1961
Branham, A. K. (1)	Research Associate	September 1, 1939 (C)
Burgers, A.	Graduate Assistant	February 1, 1961
Burr, I. W. (3)	Research Associate	February 1, 1958
Chang, T. P.	Graduate Assistant	February 1, 1961
Class, J. F.	Graduate Assistant	February 1, 1961
Critchell, C. M.	Stenographer	October 6, 1958
Delleur, J. W. (2)	Research Engineer	July 1, 1958
Dolch, W. L. (2)	Research Associate	September 15, 1947
Goetz, W. H. (3)	Research Engineer	May 13, 1938
Gutzwiller, M. J. (3)	Research Engineer	September 1, 1957
Hanna, S. J.	Graduate Assistant	September 12, 1960
James, W. P.	Graduate Assistant	September 9, 1960
Johnson, R. W.	Research Engineer	February 1, 1960
Journeaux, N. L.	Graduate Assistant	February 1, 1961
Jouzy, N. G.	Graduate Assistant	September 16, 1959
Lewis, R. M.	Research Engineer	September 1, 1960
Lippai, S.	Graduate Assistant	September 1, 1960
Lobo, C. T.	Graduate Assistant	September 15, 1960
Lohr, A. F.	Graduate Assistant	September 15, 1960
Luttrell, W. B.	Laboratory Assistant	August 6, 1938

McLaughlin, J. F. (2)	Research Engineer	September 1, 1950
Michael, H. L. (2)	Assistant Director	February 1, 1950
Miles, R. D. (2)	Research Engineer	September 1, 1949
Miller, F. D.	Graduate Assistant	February 1, 1960
Moavenzadeh, F.	Graduate Assistant	February 1, 1960
Nakamura, V. F.	Graduate Assistant	September 12, 1960
Parvis, Marla (2)	Research Engineer	March 1, 1946
Petty, D. F.	Research Assistant	February 1, 1959
Soudisari, P. F.	Graduate Assistant	June 1, 1960
Smith, Ernestine	Purchasing Clerk	September 22, 1960
Stover, V. G.	Research Assistant	September 1, 1958
Tharp, K. J.	Research Engineer	June 1, 1961
Wann, C. D.	Typist	February 16, 1959
Woods, K. B. (4)	Director	February 1, 1939
Yeh, P. T. (1)	Research Engineer	February 1, 1953
Yoder, E. J. (2)	Research Engineer	September 1, 1949 (D)

(1) Assistant Professor (3) Professor

(2) Associate Professor (4) Head

A. Resigned May 31, 1957 and reappointed September 1, 1957, then resigned June 14, 1958 and reappointed January 22, 1959.

B. Resigned June 30, 1956 and reappointed February 1, 1958.

C. Resigned August 18, 1941 and reappointed August 1, 1949. On leave of Absence 1960-61.

D. Resigned December 31, 1947 and reappointed September 1, 1949.

New Staff Members During Past Year

July 1, 1960 to June 30, 1961

Name	Rank	Degree Held	School	Date Appointed
Brahma, S. P.	Graduate Assistant	1953 BS 1961 MSE	Calcutta Purdue University	February 1, 1961
Burgers, A	Graduate Assistant	1949 BS	Notal University	February 1, 1961
Chang, T. P.	Graduate Assistant	1955 BS	Nat. Tawan University	February 1, 1961
Class, J. F.	Graduate Assistant	1961 BSCE	Purdue University	February 1, 1961
Crist, R. L.	Research Assistant	1949 BSCE 1957 MSEA	Univ. of Illinois Purdue University	July 1, 1960
Gondo, K.	Graduate Assistant	1957 BSE 1961 MSE	Univ. of Tokyo Purdue University	September 16, 1960
Hanna, S. J.	Graduate Assistant	1960 BSCE	Purdue University	September 12, 1960
Ingram, G. E.	Research Engineer	1949 BSCE 1957 MCEE 1959 PhD	Univ. of Arizona Purdue University Purdue University	July 1, 1960
James, W. P.	Graduate Assistant	1957 BSCE 1961 MSCE	Montana State College Purdue University	September 9, 1960
Journeaux, N. L.	Graduate Assistant	1960 BSE	Queen's University	February 1, 1961
Lewis, R. M.	Research Engineer	1952 BS 1953 BCE 1959 MCE	Trinity College, Conn. R.P.I. R.P.I.	September 1, 1960
Lippai, S.	Graduate Assistant	1960 BSCE	Purdue University	September 1, 1960

Lobo, C. T.	Graduate Assistant	1955 1960	BCE MSCE	L.D. Engrg. College Univ. of Notre Dame	September 15, 1960
Lohr, A. F.	Graduate Assistant	1960	BSCE	South Dakota State	September 15, 1960
Makamura, V. F.	Graduate Assistant	1960	BSCE	Univ. of Hawaii	September 12, 1960
Soady, R. W.	Graduate Assistant	1951 1961	BSCE MSCE	Univ. of Miami Purdue University	February 1, 1961
Tharp, K. J.	Research Engineer	1947 1961	BSCE MSCE	Iowa State No. Carolina St. College	June 1, 1961
Smith, Ernestine	Purchasing Clerk				September 22, 1960

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Staff Resignations During the Past Year

July 1, 1960 to June 30, 1961

Name	Rank	Degree Held	School	Appointed	Resigned
Blery, P. F.	Graduate Assistant	BSE 1959 MSCE 1961	Purdue University Purdue University	8/1/59	1/31/61
Crist, R. L.	Research Assistant	BSE 1949 MSEd 1957	University of Illinois Purdue University	7/1/60	8/31/60
Dunn, K. H.	Research Assistant	BSE 1950 MSCE 1958	Missouri School of Mines Missouri School of Mines	9/1/58	6/30/61
Fletcher, J. A.	Graduate Assistant	BSE 1957 MSCE 1961	Ohio University Purdue University	9/1/59	4/30/61
Gaudette, N. G.	Graduate Assistant	BSE 1956 MSCE 1961	St. Martin's College Purdue University	9/1/58	1/31/61
Gondo, K.	Graduate Assistant	BSE 1957 MSE 1961	University of Tokyo Purdue University	9/16/60	5/31/61
Grey, W. H.	Graduate Assistant	BSE 1958 MSCE 1960	St. Martin's College Purdue University	9/1/58	8/15/60
Hampton, Delon	Research Assistant	BSE 1954 MSCE 1958 Ph D 1961	University of Illinois Purdue University Purdue University	2/1/57	6/30/61
Haymes, J. H.	Graduate Assistant	BS 1956 MSCE 1961	University of Oklahoma Purdue University	6/1/59	6/30/61
Ingram, G. E.	Research Engineer	Assoc. of Arts 1947 BSE 1949 MSCE 1957 Ph D 1959	Phoenix University of Arizona Purdue University Purdue University	7/1/60	8/31/61

Name	Rank	Degree Held	School	Appointed	Resigned
Schaub, J. K.	Research Assistant	BSCE 1948	Virginia Polytechnic Inst.	7/1/57	8/15/60
		MSCE 1949	Harvard University		
		Ph D 1960	Purdue University		
Schenler, W. W.	Graduate Assistant	BSCE 1947	Purdue University	7/20/59	11/30/61
		MSCE 1950	Purdue University		
		Ph D 1961	Purdue University		
Schnuster, R. L.	Research Engineer	BS Geol. 1950	State College of Washington	2/1/57	9/30/60
		MS Geol. 1952	Ohio State University		
		MSCE 1958	Purdue University		
		Ph D 1960	Purdue University		
Seady, R. W.	Graduate Assistant	BSCE 1951	University of Miami	2/1/61	5/31/61
		MSCE 1961	Purdue University		
Terrel, R. L.	Graduate Assistant	BSCE 1960	Purdue University	2/1/60	6/30/61
		MSCE 1961	Purdue University		
Tseo, L. C.	Graduate Assistant	BS 1953	Taiwan College of Engrg.	9/1/58	8/12/60
		MSCE 1960	Purdue University		
Walker, R. D.	Research Assistant	BSCE 1953	University of Maryland	9/15/53	3/31/61
		MSCE 1955	Purdue University		
		Ph D 1961	Purdue University		
Wu, I. P.	Graduate Assistant	BS (Agr) 1955	Taiwan University	9/1/59	6/30/61
		MS 1958	Purdue University		
Deck, Karen	Purchasing Clerk			9/8/59	10/18/60

PUBLICATIONS

Papers, Bulletins, Reprints, and Theses

July 1, 1960 to June 30, 1961

Research Activities Bulletin-Engineering Experiment Station*
(From January 1936 to date)

EES Bull.	Vol.	No.	Date	Publications (inclusive)	Period Covered
83	25	5	Sept. 1941	1P - 45P	Jan. 1936 - June 1941
85	26	4	July 1942	46P - 60P	July 1941 - June 1942
91	27	6	Nov. 1943	61P - 73P	July 1942 - June 1943
94	29	1	Jan. 1945	74P - 91P	July 1943 - June 1944
96	29	4	July 1945	92P - 103P	July 1944 - June 1945
100	31	1	Jan. 1946	104P - 124P	July 1945 - June 1946
102	31	5	Sept. 1947	119P - 157P	July 1946 - June 1947
107	33	1	Jan. 1949	158P - 176P	July 1947 - June 1948
110	34	2	Mar. 1950	177P - 212P	July 1948 - June 1949
113	35	4	July 1951	213P - 243P	July 1949 - June 1950
116	36	3	May 1952	244P - 272P	July 1950 - June 1951
119	37	3	May 1953	273P - 307P	July 1951 - June 1952
120	37	6	Nov. 1953	308P - 345P	July 1952 - June 1953
122	38	6	Nov. 1954	346P - 374P	July 1953 - June 1954
126	39	6	Nov. 1955	375P - 400P	July 1954 - June 1955
132	40	4	Dec. 1956	401P - 442P	July 1955 - June 1956
136	41	4	Dec. 1957	443P - 472P	July 1956 - June 1957
139	43	1	Mar. 1959	473P - 509P	July 1957 - June 1958
141	44	3	May 1960	510P - 535P	July 1958 - June 1959
143	45	1	Jan. 1961	536P - 568P	July 1959 - June 1960

* Also see EES Bulletin No. 99 which covers a complete listing of publications 1-122P. These Bulletins contain summaries of the various research projects as well as some information on the publications by the staff. The Abstracts Bulletin initiated in 1956 contains a short abstract of each staff publication or thesis.

Abstracts of Engineering Staff Publications and Theses
(From 1955 to date)

<u>EES Bull.</u>	<u>Vol.</u>	<u>No.</u>	<u>Date</u>	<u>Includes</u> <u>Publications</u>	<u>Period</u>
133	41	1	March 1957	401P - 442P	July 1955 - June 1956
137	42	1	March 1958	443P - 472P	July 1956 - June 1957
140	43	2	June 1959	473P - 509P	July 1957 - June 1958
142	44	4	July 1960	510P - 535P	July 1958 - June 1959
144	45	3	May 1961	536P - 568P	July 1959 - June 1960

Reprints

- 569P "Laboratory Research on Pavements Continuously Reinforced with Welded Wire Fabric" by M. J. Gutzwiller and J. L. Waling, Bulletin 238, Highway Research Board, Washington, D. C., pp. 39-47, 1960 (Civil Engineering Reprint No. 176).
- 570P "Crack Formation in Continuously-Reinforced Pavements" by M. J. Gutzwiller and J. L. Waling, Bulletin 238, Highway Research Board, Washington, D. C., pp. 64-77, 1960 (Civil Engineering Reprint No. 177).
- 571P "Transportation and Economic Potential in the Arctic" by K. B. Woods and R. F. Legget, Traffic Quarterly, October 1960 (Civil Engineering Reprint No. 179).
- 572P "Stresses and Deflections in Concrete Pavements Continuously Reinforced with Welded Wire Fabric" by M. J. Gutzwiller and J. L. Waling, Bulletin 238, Highway Research Board, Washington, D. C., pp. 48-63, 1960 (Civil Engineering Reprint No. 180).
- 573P "Designing Fine Bituminous Mixtures for High Skid Resistance" by J. E. Stephens and W. H. Goetz, Highway Research Board Proceedings, Vol. 39, pp. 173-190, 1960 (Civil Engineering Reprint No. 181).
- 574P "Design of a Pressure-Sensitive Cell and Model Studies of Pressures in a Flexible Pavement Subgrade" by T. F. McMahon and E. J. Yoder, Highway Research Board Proceedings, Vol. 39, pp. 650-682, 1960 (Civil Engineering Reprint No. 183).
- 575P "Photogrammetric Measurement of Final Pay Quantities in Highway Construction" by R. R. Johnson and R. D. Miles, Proceedings of the 46th Annual Road School, Purdue University, Extension Series No. 105, Vol. 44, No. 6, pp. 253-269, November 1960 (Civil Engineering Reprint No. 185).

- 576F "Locating Slippery Highway Sites by Accident Analysis" by V. G. Stover and H. L. Michael, Proceedings of the 46th Annual Road School, Purdue University, Extension Series No. 105, Vol. 44, No. 6, pp. 236-253, November 1960 (Civil Engineering Reprint No. 186).
- 577F "Highway Extension and Research Project for Indiana Counties" by K. B. Woods, Proceedings of the 46th Annual Road School, Purdue University, Extension Series No. 105, Vol. 44, No. 6, pp. 209-218, November 1960 (Civil Engineering Reprint No. 187).

Theses

- 578P "Strength and Volume Change Characteristics of a Bituminous Mixture under Triaxial Testing" A thesis submitted to the faculty of Purdue University by James H. Schaub in partial fulfillment of the requirements for the degree of Doctor of Philosophy, August 1960.
- 579P "The Fatigue Properties of Lightweight Aggregate Concrete" A thesis submitted to the faculty of Purdue University by Warren H. Gray in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering, August 1960.
- 580P "A Method of Evaluating Gradings of Concrete Aggregates" A thesis submitted to the faculty of Purdue University by Sador Popovics in partial fulfillment of the requirements for the degree of Doctor of Philosophy, January 1961.
- 581P "Evaluation of Major Urban Intersections" A thesis submitted to the faculty of Purdue University by William W. Schenler in partial fulfillment of the requirements for the degree of Doctor of Philosophy, January 1961.
- 582P "A Study of Chert and Shale Gravel in Concrete" A thesis submitted to the faculty of Purdue University by Robert L. Schuster in partial fulfillment of the requirements for the degree of Doctor of Philosophy, January 1961.
- 583P "Application of the Kneading Compactor and Hveem Stabilometer to Bituminous Concrete Design in Indiana" A thesis submitted to the faculty of Purdue University by Noel G. Gaudette, Jr. in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering, January 1961.
- 584P "Hydraulics of Single Span Arch Bridge Constrictions" A thesis submitted to the faculty of Purdue University by Paul F. Biery, Jr. in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering, January 1961.
- 585P "Statistical Analysis of Soil Variability" A thesis submitted to the faculty of Purdue University by Delon Hampton in partial fulfillment of the requirements for the degree of Doctor of Philosophy, June 1961.

- 586P "Evaluation of a Flexible Test Pavement" A thesis submitted to the faculty of Purdue University by Richard D. Walker in partial fulfillment of the requirements for the degree of Doctor of Philosophy, June 1961.
- 587P "A study of the Early Effects of a Rural Interstate Highway" A thesis submitted to the faculty of Purdue University by Joseph A. Fletcher, Jr. in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering, June 1961.
- 588P "Effects of Repeated Loading on Gravel and Crushed Stone Base Course Materials Used in the AASHO Road Test" A thesis submitted to the faculty of Purdue University by John H. Haynes in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering, June 1961.
- 589P "Classification and Glossary of Land Forms and Parent Materials" A thesis submitted to the faculty of Purdue University by Ronald L. Terrel in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering, June 1961.

Other Publications

- 590P "Uniformity of Traffic Control -- Has it Been Achieved?", H. L. Michael, Traffic Quarterly, Vol. XV, No. 1, January 1961 (Also in The Alabama Municipal Journal, Vol. 18, No. 9, March 1961).
- 591P "Estimation of County Primary Road System Needs By Sample Survey Methods," D. O. Covault and H. L. Michael, Highway Research Board Bulletin 249, 1960.
- 592P "The Planning Function of Traffic Engineering," H. L. Michael, Proceedings, 46th Annual Road School, Purdue University, Vol. 44, No. 6, Series No. 105, Nov. 1960.
- 593P "Mission of ACR," W. L. Dolch, Materials Research and Standards, Vol. 1, No. 1, January 1961.
- 594P "Basic Principles of Pavement Design," E. J. Yoder, Public Works, March-April-May 1961.
- 595P "Photo Interpretation of Soils," Manual of Photographic Interpretation, P. T. Yeh and R. D. Miles with R. E. Frost, et al, American Society of Photogrammetry, 1960.
- 596P "The Use of Aerial Photos for Planning and Site Selection," R. D. Miles, Proceedings, Great Lakes States Industrial Development Council, 1961.

Note: In addition, "Proceedings of the 46th Annual Purdue Road School," Extension Series 105, Vol. 44, No. 6, November 1960; "1961 Directory, Indiana State, County and City Highway Officials, and "Highway Extension News," issued periodically were edited by J. F. McLaughlin and published by the Joint Highway Research Project.

JOINT HIGHWAY RESEARCH PROJECTS AND ADVISORY BOARD REPORTS
July 1, 1960 to June 30, 1961

Report and No.	Proj. 6-36	Author	Date	Pages	Figs.	Bk.	Vol.	No.	Pt.	Pgs.
1063-Plan of Study, "The Effect of Traffic Control Devices at School Crossings"	1771	Miller	8/3	10	1	139	XXII	3	A	24
1064-Plan of Study, "The Use of Radioactive Tracers in the Determination of Phase Relations Between Asphaltic Binder and Mineral Aggregates"	24B	Land	8/3	9	0	139	XXII	3	A	34
1065-Final Report, "Strength and Volume Change Characteristics of a Bituminous Mixture Under Triaxial Testing"	6F	Schaub	8/3	130	36	139	XXII	3	A	43
1066-Proposed Budget for Period October 1 - December 31, 1960		Michon	9/21	9	0	139	XXII	3	A	242
1067-Plan of Study, "A Classification and Glossary of Land Forms and Parent Materials"	30P	Wentzel	9/21	7	0	139	XXII	3	A	251
1068-Technical Paper, "Hydraulics of River Flow Under Arch Bridges"	622	Blay Bellamy	9/21	62	24	139	XXII	3	A	290
1069-Plan of Study, (Extension), "Hydraulics of River Flow Under Arch Bridges"	62B	Dellour	9/21	13	0	139	XXII	3	A	321
1070-Plan of Study, "Vehicular Characteristics on Acceleration and Deceleration Lanes"	117V	Joussy	9/21	13	0	139	XXII	3	A	334
1071-Plan of Study, "An Analysis of Photogrammetry Applied to Night-0.2-Way Snowdrift"	391	Seaton	9/21	7	0	139	XXII	3	A	247

Report and No.	Proj. C-36	Author	Date	Pages	Bk.	Vol.	No.	Pt.	Pg.
1072-Progress Report, "Traffic Speed Report No. 70; Truck-Weight Speed Study"	10D	Petty	9/22	18	6	139	XXII	3	A 354
1073-Final Report, "A Study of the Fatigue Proportions of Light-Weight Aggregate for Concrete"	56G	Gray	9/21	128	11	139	XXII	3	A 372
1074-Information Report, "Roadside Weed and Brush Control With Chemicals"	-----	Sawing	11/2	72	0	140	XXII	4	A 9
1075-Plan of Study, "An Investigation of Aggregate Degradation in the Bituminous Mixtures"	25	Moorehead	11/3	13	2	140	XXII	4	A 80
1076-Technical Paper, "A Study of the Fatigue Properties of Lightweight Aggregate Concrete"	56G	Gray McLaughlin Antonia	11/3	26	4	140	XXII	4	A 98
1077-Technical Paper, "Strength and Volume Change Characteristics of Bituminous Mixtures"	69	Schub Goeth	11/2	78	26	140	XXII	4	A 124
1078-Progress Report, "Traffic Speed Report No. 71"	10D	Miller	11/3	30	8	140	XXII	4	A 209
1079-"Annual Report of the Assistant Director, 1959-1960"	-----	Michael	11/2	54	0	140	XXII	4	A 221
1080-Proposed Budget for Period January 1 - March 31, 1961	-----	Michael	12/14	8	0	141	XXII	4	B 5
1081-Plan of Study, "Classification of Wisconsin Ground Moraine by Airphoto Interpretation" 32R	32R	James	12/14	7	0	141	XXII	4	B 10

Report and No.	Proj. C-36	Author	Date	Pages	Figs.	Pls.	Vol.	No.	Pt.	Pg.
1082-Final Report, "A Study of Chert and Shale Gravel in Concrete"	42F	Schuster	12/14	216	28	141	XXII	4	B	20
1083-Final Report, "Evaluation of Major Urban Intersections"	17T	Schenker	12/14	176	50	141	XXII	4	B	237
1084-Final Report, "Application of the Reading Compactor and Hyem Seal-Meter to Bituminous Concrete Design in Indiana"	60	Gaudette	12/14	263	48	141	XXII	4	B	414
1085-Technical Paper, "Co-operative Soil Mapping Projects in Indiana"	51P	Miller Spencer	1/25	27	7	142	XXIII	1	A	5
1086-Progress Report No. 1, "Highway Impact Studies"	---	Michael	1/25	2	0	142	XXIII	1	A	27
1087-Plan of Study, "Highway Performance Evaluation"	54PB	Nakamura	1/25	8	0	142	XXIII	1	A	30
1088-Final Report, "An Evaluation of a Flexible Pavement"	52C	Wadwa	1/25	175	48	142	XXIII	1	A	38
1089-Bibliography, "Bibliography on Dynamic Testing of Concrete"	---	Warr Hewitt	1/25	28	0	142	XXIII	1	A	225
1090-Technical Paper, "Study of Chert and Shale Gravel in Concrete"	42F	Schuster McLaughlin	1/25	61	6	142	XXIII	1	A	253
1091-Technical Paper, "The Effect on Speed and Accidents of Improved Delineation at Three Hazardous Locations"	17T	Powers Michael	1/25	30	10	143	XXIII	1	A	225

Report and to	Project	Author	Date	Page	Vol.	No.	Pt.	Page
1092-Technical Paper, "The Effect on Speed of Speed Limit Signs on Suburban Arterial Streets"	179	Elaberg Michael	1/25	35	7	142	XIII	1 A 345
1093-Technical Paper, "A Study of the Effect of Aggregate Factors on Pavement Friction"	521	Stephens Gordon	1/25	38	10	142	XIII	1 A 370
1094-Proposed Budget for Period April 1 - June 30, 1961	—	Wicks	1/25	7	0	142	XIII	2 A 15
1095-Plan of Study, "The Investigation of Precision Statements for ASHTO Test Methods"	634	Wicks	1/25	11	0	142	XIII	2 A 24
1096-Plan of Study, "Program for Investigative Research on Chemical Weathering"	1471	Wicks	1/25	6	0	142	XIII	2 A 35
1097-Progress Report, "Investigative Study of the Effect of Four Indian Methods of Bridge"	372	Wicks	1/25	7	0	142	XIII	2 A 39
1098-Final Report, "A Method of Grading Gradients of Concrete"	148	Wicks	1/25	12	1	142	XIII	2 A 46
1099-Final Report, "Investigative Study Using Kneading Concrete and Hveen Staphylococcus"	67	Wicks	1/25	50	7	142	XIII	2 A 167
1100-Final Report, "A Classification and Glossary of Land Forms and Features"	148	Wicks	1/25	12	1	142	XIII	2 A 244

Report and No.	Proj. G-26	Author	Date	Pages	Figs.	Enc.	Vol.	No.	Po.	Pg.
1101-Final Report, "Statistical Analysis of Soil Variability"	36A	Hampton	5/18	128	18	143	XXIII	2	A	397
1102-Progress Report, "Study of Runoff from Small Watersheds for Highway Drainage Design in Indiana"	62A	Ku Delleur	5/18	138	12	142	XXIII	2	A	525
1103-Technical Paper, "Hydraulics of Single Span Arch Bridge Constrictions"	62B	Bietz Delleur	5/18	55	15	143	XXIII	2	A	663
1104-Progress Report, "Report of Freezing and Thawing Tests on Concrete Containing Louisville Coarse Aggregate from Source 3-1S"	278	Arnsperg	5/18	4	0	143	XXIII	2	A	718
1105-Proposed Budget for Period July 1 - September 30, 1961		Shannon	6/21	9	0	144	XXIII	2	B	6
1106-Progress Report No. 72, "Intermittent Speed Studies"	100	Miller	6/21	21	0	144	XXIII	2	B	15
1107-Final Report, "Effects of Repeated Loading on Gravel and Crushed Stone Base Course Materials Used in the AASHO Road Test"	404	Hagness	6/21	102	29	144	XXIII	2	B	36
1108-Information Report, "An Analysis of Traffic Accidents on County Roads"		Petty	6/21	117	15	144	XXIII	2	B	126
1109-Progress Report on Studies of Highway Impact in Indiana	64	Fletcher Kriegel	6/21	14	1	144	XXIII	2	B	255

Report and No.	Proj. C-36	Author	Date	Pages	Plgs.	Ex.	Vol.	No.	Pt.	Pg.
No. 2, "Early Effects of a Portion of Interstate 65"	64B	Fletcher	6/21	64	21	144	XXIII	2	B	269
No. 3, "A Study of Partial Takings for a Portion of Interstate 65"	64C	Fletcher	6/21	41	15	144	XXIII	2	B	333
1110-Technical Paper, "Use of Acceleration-Deceleration Lanes"	17V	Jouzy Michael	6/21	34	16	144	XXIII	2	B	374
1111-Technical Paper, "Roughness Spacing in Rigid Open Channels"	62B	Perry Dellieur	6/21	15	6	144	XXIII	2	B	403

SUMMARY TABULATION OF RESEARCH PROJECTS

Status as of June 30, 1961

KEY TO STATUS NUMBERS

Key Number:

- 1. Complete-- unpublished.
- 2. Complete-- published (including completed theses).
- 3. Incomplete-- inactive.
- 4. Complete-- publication in progress.
- 5. Active-- incomplete.
- 6. Being started.
- 7. Planned.

* Resigned

Project C-36	File No.	Assigned to	Status (See Key)	Title of Project
1	6-3	Jackson*	2	<u>Test Road No. 1, old series</u>
2	6-4	Jackson*	2	<u>Test Road No. 1, new series</u>
3	6-5	Jackson*	2	<u>Test Road 2</u>
	2-3			<u>Surface Treatment</u>
	2-3-1	Shelburne*	2	A--1935 & Older Construction
	2-3-2	Shelburne*	2	B--1936 Construction
	2-3-3	Shelburne*	2	C--1937 Construction
5	6-6			<u>Laboratory Soil Studies</u>
	6-6-1	Graves*	1	A--Durability
	6-6-2	Winn*	2	B--Frost Action
	6-6-3	Kay*	2	C--Permeability
	6-6-4	Mayo*	2	D--Compression
	6-6-5	Schaub*	3	E--Compaction on Remolded Clay
6	2-4			<u>Bituminous Mixtures</u>
	2-4-1	Graves*	3	A--Pugmill
	2-4-2	Graves*	1	B--Patch Materials
	2-4-3	Graves*	3	C--Unconfined Compression Tests
	2-4-4	Layman*	2	D--Unconfined Compression & Squeeze Tests
	2-4-5	Chen*	2	E--Stability
	2-4-6	McLaughlin	2	F--Resurface Mixtures
	2-4-7	Herrin*	2	G--Particle Shape
	2-4-8	Havers* & Dusenbury*	2	H--Rubber Asphalt
	2-4-9	Osili*	2	I--Seal Coats

Project C-36	File No.	Assigned to	Status (See Key)	Title of Project
	2-4-10	Wood	2	J--Str. & Deform. Charac.
	2-4-11	Oppenlander*	2	K--Triaxial Testing at High Pressure
	2-4-11	Zaggara*	2	L--Aggregate Bitumen Mixtures
	2-4-12	Goetz	2	M--Strength by Marshall Test
	2-4-14	Dennis*	2	N--Repeated Load Test Evaluation
	2-4-15	Wood	2	O--Rheological Characteristics
	2-4-16	Schraub*	2	P--Shear Strength
	2-4-17	Hannan*	2	Q--Testing - Hyem Stabilometer
	2-4-18	Gaudette*	2	R--Stability Tests - Stabilometer & Compactor
7	2-5			<u>Rock Asphalt</u>
	2-5-1	Goetz, Tyler*	2	A--Exploratory Study
8	2-6			<u>Bituminous Adhesion</u>
	2-6-1	Goetz	2	A--Untreated
	2-6-2	Tyler*	3	B--Treated
	2-6-3	Andersland*	2	C--Sonic Test Evaluation
9	5-3			<u>Aggregate Degradation</u>
	5-3-1	Shelburne*	2	A--Under Road Rollers
10	8-3			<u>Traffic Speeds</u>
	8-3-1	Lawche*	2	A--Bibliography
	8-3-2	Brerham*	2	B--Equipment Development
	8-3-3	Staff	5	C--Periodic Speed Studies
	8-3-4	Staff	5	D--Truck Speed - Weight Study
11	9-1			<u>Climatic Data</u>
	9-1-1	Staff	1	A--Winter Weather 1935-51
12	2-7			<u>Test Road No. 3</u>
	2-7-1	Goetz, Shelburne*	2	A--Resurvey
	2-7-2	Chang*	2	B--Sample Tests
13	6-7	Belcher*	2	<u>Test Rd. Sur. Treat.</u>
14	6-8			<u>Triaxial Tests</u>
	6-8-1	Yoder	1	A--U. S. 41 Test Road
	6-8-2	Yoder, Wood, Hampton*	2	B--Effect of Rate of Loading
	6-8-3	Gregg*	2	C--Soil and Soil Mixtures
15	6-9			<u>Drainage</u>
	6-9-1	McAlpin*	2	A--Small Models
	6-9-2	McClelland*	2	B--Large Models
	6-9-3	Kut*	2	C--Capillarity
	6-9-4	Hittle	3	D--Capillary Potential
	6-9-5	Robertson*	2	E--Permeability
	6-9-6		3	F--Agg. Grad. for Drains

Project 5-26	File No.	Assigned to	Status (See Key)	Title of Project
	6-9-7	Slesser*	1	G--Soil-Vapor Press.
	6-9-8	Yeh	2	H--Hydrology
	6-9-9	Kashef*	2	I--Numerical Solution to Flow Problems
16	6-10			<u>Field Soil Temp. and Moisture</u>
	6-10-1	Yoder & Lowrie*	2	A--Field Installations
	6-10-2	Lemert* & Lovell	3	B--Soil Temp. Gages
	6-10-3	Lovell	3	C--Soil Mois. Meas. Dev.
	6-10-4	Lovell	1	D--Freezing Index Maps
17	8-4			<u>Traffic Engineering Research</u>
	8-4-1	Green*	3	A--Signs
	8-4-2	Wilson*	2	B--Intersections
	8-4-3	Green*	3	C--Pvt. Usage
	8-4-4	O'Mara*	2	D--Accidents
	8-4-5	Quinby*	2	E--Effect of Narrow Bridges
	8-4-6	Overmyer*	2	F--Width, Pavement
	8-4-7	Baerwald*	2	G--Public Opinion Poll
	8-4-8	Lang*	2	H--Shoulders Influence
	8-4-9	Barclay*	2	I--Bibliography
	8-4-10	Baerwald*	3	J--Effect of Median Strip
	8-4-11	MacNaughton*	2	K--Turn Lane Controls
	8-4-12	Rosenfield*	2	L--Lateral Placement of Vehicles
	8-4-13	Baerwald*	1	M--Drive-In Theater Traffic
	8-4-14	Powers*	2	N--Intersectional Delineation
	8-4-15	Jackman*	2	O--Driver Obedience to Signs
	8-4-16	Barr*	2	P--Scramble System
	8-4-17	Cooper*	2	Q--4-Way Stop
	8-4-18	Weekesser*	2	R--Edge Stripping Effect on Lateral Placement
	8-4-19	Elmborg*	2	S--Speed Zoning
	8-4-20	Schenler*	2	T--Evaluation of Urban Intersections
	8-4-21	Miller	5	U--School Crossing Protection
	8-4-22	Jouzy	5	V--Acceleration and Deceleration Lanes
18	5-4			<u>Chart in Aggregate</u>
	5-4-1	Sweet*	2	A--In Indiana
	5-4-2	Popovics*	2	B--Method of Improving Durability
19	5-5			<u>Concrete General</u>
	5-5-1	Jones*	2	A--Phys. Characteristics
	5-5-2	Robertson*	1	B--Cores, U. S. No. 40
	5-5-3	Jones*	1	C--Fatigue
20	4-3			<u>Salt Migration</u>
	4-3-1	Slesser*	2	A--Laboratory
	4-3-2	Frost*	1	B--Route 30 Heave
	4-4-3	Frost*	1	C--Buffalo-Reporte

Project C-36	File No.	Assigned to	Status (see Key)	Title of Project
21.	2-8			<u>Aggregates</u>
	2-8-1	Hetcali*	2	A--Sandstone
	2-8-2	Riser*	2	B--Sands
	2-8-3	Moavonzadeh	5	C--Aggregate Degradation
22	3-9			<u>Bituminous Emulsions</u>
	3-9-1	Tyler*	2	A--Bituminous Emulsions
23	5-6			<u>Concrete Sealing</u>
	5-6-1	Green*	3	A--Linseed Oil
	5-6-2	Green*	3	B--Field Studies
	5-6-3	Green*, Shelburne*	3	C--U. S. 20 Study
24	2-10			<u>Bituminous Structures</u>
	2-10-1	Tonawits*	2	A--Microscopic Technique
	2-10-2	Lamb	5	B--Radioactive Tracers for Phase Relationships
25	3-2			<u>Dynamic Modulus</u>
	3-2-1	Bawa*	2	A--Bit--Agg. Mix.
	3-2-2	Whitehurst*	2	B--Time of Set
	3-2-3	Yong*	2	C--Sonic vs. Mech. Test of Bitum. Mix.
	3-2-4	Whitehurst*	2	D--Soil-Cement and Soil-Lime
	3-2-5	Whitehurst*	2	E--Field Use
26	4-4			<u>Paints</u>
	4-4-1	Goetz	2	A--Traffic Paints
	4-4-2	Goetz	1	B--Blackout Paints
	4-4-3	Goetz	3	C--Laboratory & Field
	4-4-4	Goetz	3	D--Bridge Paint
	4-4-5	Blackburn*, Dolch	2	E--Waterproofing
	4-4-6	Goetz	3	F--Prison Paints
27	4-11	Shelburne*	1	<u>Test Road No. 4</u>
28	9-3			<u>Photoelasticity</u>
	9-3-1	Woodsmall*	2	A--Subg. Stress
	9-3-2	Baker*	2	B--Calculations
	9-3-3	Hittle	1	C--Dowel Bars
	9-3-4	Hittle	1	D--Cons. Arch
29	1-3			<u>Aerial Strip Maps</u>
	1-3-1	Mattes*	3	A--Highway Locations
	1-3-2	Hittle	2	B--Use of Strip Maps
	1-3-3	Miles	2	C--Strip Map Location
30	9-4			<u>Geology</u>
	9-4-1	Woods, Yoder & Johnstone*	2	A--Proglacial Marietta River

Project C-36	File No.	Assigned to	Status (See Key)	Title of Project
31	2-11			<u>Bituminous Performances</u>
	2-11-1	Shelburne*	1	A--Route 26
	2-11-2	Shelburne*	1	B--Route 17
	2-11-3	McLaughlin, Goetz	3	C--Bituminous Concrete Stability
	2-11-4	Shelburne*	1	D--Spring Breakup 1943
	2-11-5	Goetz*	1	E--Spring Breakup 1945
	2-11-6	Goetz	1	F--Spring Breakup 1951
	2-4			<u>Airphoto Interpretation</u>
	1-4-1	Belcher*	2	A--Granular Materials
	1-4-2	Frost*	3	B--Rough Topography
	1-4-3	Parvis	3	C--Airphoto Bibliography
	1-4-4	Frost*	1	D--Use in Location
	1-4-5	Parvis	2	E--Use in Drainage
	1-4-6	Kentano*	3	F--Indiana Soils - Northern
	1-4-7	Frost*	3	G--Indiana Soils - Southern
	1-4-8	Frost*	1	H--U. S. 40, Terre Haute
	1-4-9	Mollard*	1	I--Valparaiso Moraine
	1-4-10	Mishmure*	2	J--Erie Moraines
	1-4-11	Howe*	2	K--Ground Water
	1-4-12	Miles	2	L--Topographic Mapping
	1-4-13	Bailey*	2	M--Mapping for Preliminary Location
	1-4-14	Parvis	5	N--Determination of Runoff
	1-4-15	Johnson*	2	O--Measurement of Final Quantities
	1-4-16	Ternet*	2	P--Glossary of Land Forms & Parent Materials
	1-4-17	Scudieri	5	Q--Photogrammetry to R/W Surveys
	1-4-18	James	5	R--Class. of Wisconsin Ground Moraine
32	6-10	McAlpin*, Belcher*	1	<u>Test Road No. 5</u>
33	6-13	Belcher*	1	<u>Test Road No. 6</u>
35	5-7			<u>Cons. Performances</u>
	5-7-1	Shelburne*	1	A--Route 67
	5-7-2	Tung*	1	B--Route 29
	5-7-3	Shelburne*	1	C--Route 6
	5-7-4	Shelburne*	1	D--Route 30
	5-7-5	Shelburne*	1	E--Roughness
	5-7-6	Camp*	1	F--U. S. No. 50
36	6-14			<u>Indiana Soil Problems</u>
	6-14-1	Hampton*	2	A--Statistical Analysis of Soil Sampling
	6-14-2	Lennertz*	2	B--Geophysical Testing
	6-14-3	Larow*	2	C--Landslides
	6-14-4	Woods	2	D--Soil Surveys
	6-14-5	Shurig	2	E--Subsurface Exploration
	6-14-6	Moore*	2	F--Airphoto Evaluation

File No.	Assigned To	Status (See Key)	Title of Project	
37	5-3		<u>Conc. Durability</u>	
5-8-1	Shelbourne*	3	A--Curing	
5-8-2	Sweet*, Woods	2	B--Base Courses	
5-8-3	Socr*	3	C--Aggregate Absorption	
5-8-4	Iowley*, Sweet*	3	D--Sonic Lab.	
5-8-5	Lewis*, Sweet*	3	E--Sonic Field	
5-8-6	Clauser*, Lux*	3	F--Coef. Expansion	
5-8-7	Hogg*	2	G--Air Entrn. Admixtures	
5-8-8	Blackburn*	2	H--Disintegration Bibliography	
5-8-9	Fendley*	2	I--Restraint Effects	
5-8-10	Lee*	2	J--Therm. Shock	
5-8-11	Fears*	2	K--Pore Charac.	
5-8-12	Higget*, McLaughlin	3	L--Fine Aggregate	
5-8-13	Blackburn*	2	M--Agg. Dur. in Air-Entr. Conc.	
5-8-14	Berkley*	3	N--Concr. Admix.	
5-8-15	Batchelder*	2	O--Strength and Dynamic Properties	
5-8-16	Venters*, Lewis*, McLaughlin	2	P--Gravel, Non-durable Constituents	
5-8-17	Batchelder*, Fears*	2	Q--Air Content, Hardened Concrete	
5-8-18	Lewis*, Whitehurst*, McLaughlin	3	R--Bridge Concrete, Deterioration	
5-8-19	Lewis*, Irick*, Blackburn*	2	S--Variability of Durability Tests	
5-8-20	Walker*	2	T--Gravel-Stone Mixt.	
5-8-21	McLaughlin	2	U--HRB Cooperative Study	
5-8-22	McLaughlin	3	V--Dur. Pre-Stressed Conc.	
5-8-23	McLaughlin	3	W--Air-Entr. Conc. Pave. Survey	
5-8-24	McLaughlin	5	X--Freeze Thaw Tests	
5-8-25			Y--	
5-8-26	Delch, McLaughlin	5	Z--Dampproofing Treatment of Bridges	
38	6-15		<u>Soil Mapping</u>	
6-15-1	Frost*, Hittle	2	A--Field and Lab.	
6-15-2	Frost*	1	B--Route 20	
6-15-3	Frost*	1	C--U. S. No. 31	
39	7-3		<u>Highway Loading</u>	
7-3-1	Woods	2	A--Loading and Design Trends	
40	6-16	Belcher*	1	<u>Test Road 7</u>
41	4-5		<u>Plastics</u>	
4-5-1	Yohalem*	2	A--Durability	
4-5-2	Lewis*	2	B--Strength	
4-5-3	Slate*	3	C--New Plastic & Signs	
4-5-4	Slate*	2	D--Centerline Markings	
42	5-9		<u>Aggregate Survey</u>	
5-9-1	Sweet*	2	A--Significance of Tests	
5-9-2	Woods	2	B--Origin & Destn.	

Project No.	File No.	Assigned To	Status (See Key)	Title of Project
9-9-5		Proctor*	2	G--Biblio. Aggreg.
9-9-4		Lewis*, McLaughlin	3	D--Specifications
9-9-5		Lewis*, McLaughlin, Schuster*	1	E--Indiana Sources
9-9-6		McLaughlin, Schuster*	2	F--Further Studies of Deleterious Substances
9-9-7		Superdock*	2	G--Evaluation of Aggregate Gradings
9-17				<u>Pedological Soils</u>
9-17-1			3	A--St. Dens. Proctor
9-17-2		Hittle	3	B--Typ. Proctor Curves
9-18				<u>Concrete Pumping</u>
9-18-1		Green*	2	A--Field Surveys, 1943 and 1947
9-18-2		Shelburne*, Green*	2	B--Prt. Jack
9-18-3		Getz, Green*	2	C--Pumping Mixtures
9-18-4		Getz	3	D--Rig. Prt. Salvage
9-18-5		Lewis*	1	E--1951 Survey
9-18-6		Lewis*	1	F--1954 Survey
9-18				<u>Base Courses</u>
9-18-1		Yoder	2	A--Gran. Bases - Lab.
9-18-2		Henderson*	2	B--U. S. 30 Bases
9-18-3		Sooni*	1	C--Temp. vs. Compaction
9-18-4		Pollard*	3	D--Sand-Clay Distribution
9-18-5		McCullough*	3	E--Ind. Sand-Clay Characteristics
9-18-6		Yoder & Irick*	3	F--Rigid Pavement on Gran. Bases
9-18-7		Johnson	5	G--Soil Aggregate, Repeated Loading, Pore Water Pressures
9-18-8		Haynes*	5	H--ASHO Base Materials, Repeated Loading
5-11				<u>Conc. Prt. Design</u>
5-11-1		Shelburne*	1	A--Deflection Stud.
5-11-2		Sweet* & Woods	2	B--Blowup Survey-Perf.
5-11-3		Hittle	1	C--Thin Prt. Surv.
5-11-4		Lewis*	2	D--Resurf. Prt. Surv.
5-11-5		Lewis*	1	E--Joint Perf. Surv.
5-11-6		Lewis*	1	F--Load Trans. Device
5-11-7		Camp*	1	G--Conc. Exp.
5-11-8		Melville*	1	H--Conc. Exp.
5-11-9		Okamoto*	1	I--Freeze and Thaw
5-11-10		Lewis*	1	J--Resurvey of Blowups
5-11-11		Schnebeli*, Thoma* & Lewis*	3	K--Strain Gauges
5-11-12		Choksi*	2	L--Structural Design Bibliography
5-11-13		Miller*	2	M--Theoretical Strains & Stresses

Project No.	Author	Status (See Key)	Field of Study
4-1	Barber	3	<u>Chemistry of Concrete</u>
4-2		3	A--Gels
4-3	Barber	3	B--Thin Sections
4-4	Barber	3	C--Solubility of Aggregates
4-5	Barber	2	D--Bibliography
4-6	Barber	2	E--Thermal
4-7	Barber	2	F--Aggr. Voids
4-8	Barber	2	G--Alkali Aggregate Reaction
5-1			<u>Turf Studies</u>
5-2		2	A--Early Studies
5-3	Parsons, Shay	5	B--Chemical Weed Control
6-1			<u>Soil Stabilization</u>
6-2	Parsons*	1	A--Chemical
6-3	Wills*	1	B--Molasses
6-4	Parsons*, Dolch, & Yoder	1	C--Lime
6-5	Parsons*	2	D--Bibliography
6-6	Parsons*	2	E--Soil Cal. Chloride Mix
6-7	Yoder	1	F--Test Road Using DDAC
7-1			<u>Soil Drainage Mapping</u>
7-2	Parvis, Yeh, Magnusson*	2	A--Drainage Maps
7-3	Montano*, Yeh	5	B--Soils Maps
7-4	Moultrop*	2	C--Leess Mapping
7-5	Malzerren*	2	D--SW Indiana Interbedded Shale
7-6			E--
7-7	Stylianopoulos*	2	F--SS and Shale of SW Indiana
7-8	Robbins*	3	G--IS and Shale of SE Indiana
7-9	Leighty*	2	H--Alluvial Terraces
7-10	McGregor*	2	I--Agriculture Soil Map Use
7-11	Yeh	5	J--State Drainage Map
7-12	Montano*, Yeh	2	K--State Soils Map
7-13	Dawson*	2	L--SS and Shale of SE Indiana
7-14	Van Til*	2	M--IS of SE Indiana
7-15	Stevens*	2	N--Illinoian Glacial Drift, SE Indiana
7-16	Johnson*	2	O--Northern Indiana Sands
7-17	Richert*	2	P--SS and Shale Areas
7-18	Davis*	2	Q--NW Indiana Moraines
7-19	Mintzer*	2	R--Illinoian Glacial Drift, SW Indiana
8-1			<u>Pavement Design</u>
8-2	Ardaman* & Yoder	2	A--C.E.R. Tests
8-3	Yoder	5	B--Flexible Pavement Design
8-4	Walker*	5	C--Deflection U. S. 31 Test Road

Project No.	Project Name	Status (See Key)	Project Description
2-1-4	McIntosh	2	L--Soil Pressure, Ind. Flexible Pave.
2-1-5	McIntosh	3	E--Repetitive Loading Tests
2-1-6	McIntosh & Elder	5	F--Interaction of Variables on Stresses
<u>Road Roughness & Skid</u>			
2-2-1	McIntosh*, Thomas*, Miller*	2	A--Equipment, Roughness
2-2-2	McIntosh*, Baerwald*	2	B--Skid Resistance Equipment
2-2-3	McIntosh*	1	C--Skid Characteristics Bibliography
2-2-4	McIntosh*	2	D--Bit. Mixtures Skid Characteristics
2-2-5	McIntosh*, Michael, Shupe*	2	E--Skid Resistance of U. S. 31 Test Road
2-2-6	McIntosh*, Weckesser*	2	F--Lateral Placement of U. S. 31 Test Road
2-2-7	McIntosh*, Michael	2	G--Skidding Characteristics, Ind.
2-2-8	McIntosh*, Shupe*	2	H--Skid Tests on U. S. 421
2-2-9	Holloway*	2	I--Roughness Characteristics
2-2-10	Stephens*	2	J--Effects of Aggregate on Skidding
<u>Plans & Admin.</u>			
3-1-1	Michael	3	A--Wabash River Bridge
3-1-2	May*	2	B--Lebanon Bypass
3-1-3	Michael	2	C--Kokomo Bypass
3-1-4	Baerwald*	2	D--Public Opinion Poll
3-1-5	Branham*, Baerwald*	2	E--County Road Marking
3-1-6	Branham*, Baerwald*	3	F--Cost Allocation
3-1-7	May* & Yoder	3	G--Air Transportation
3-1-8	May*	3	H--Laf. Trans. Study
3-1-9	May*	2	I--Logansport Study
3-1-10	Michael	2	J--Richmond Study
3-1-11	Michael	3	K--Bloomington Study
3-1-12	Bauer*	3	L--Logansport Parking
3-1-13	Kell*	2	M--C-D Surv. Methods
3-1-14	Stoner*, Petty*, Woods, & Branham*	2	N--Co. Highway Admin.
3-1-15	Miller*	2	O--Sampling Techniques
3-1-16	Baerwald*	2	P--County Classification
3-1-17	Michael & Edwards*	2	Q--Huntington Survey
3-1-18	Baerwald*	2	R--Allen Co. Study
3-1-19	Branham*	2	S--Recruitment of Engineers
3-1-20	Michael	2	T--State Highway Needs Study
3-1-21	May*	2	U--Evaluation of Limited Access Highways
3-1-22	Barr*	2	V--Urban Characteristics for C-D Surveys
3-1-23	Cribbins*	2	W--Northern Indiana Seaport

1. The first part of the paper discusses the importance of the study and the objectives of the research.

2. The second part of the paper describes the methodology used in the study, including the data collection and analysis techniques.

3. The third part of the paper presents the results of the study, which show a significant positive correlation between the variables.

4. The fourth part of the paper discusses the implications of the findings and provides recommendations for future research.

5. The fifth part of the paper concludes the study and summarizes the main findings.

6. The sixth part of the paper provides a detailed discussion of the limitations of the study and the potential for bias.

7. The seventh part of the paper discusses the ethical considerations of the study and the measures taken to ensure integrity.

8. The eighth part of the paper provides a detailed discussion of the contributions of the study to the field of research.

9. The ninth part of the paper discusses the practical applications of the findings and the potential for policy change.

10. The tenth part of the paper provides a detailed discussion of the future research agenda and the potential for further exploration.

11. The eleventh part of the paper discusses the role of the researcher in the study and the importance of transparency.

12. The twelfth part of the paper provides a detailed discussion of the conclusions of the study and the overall findings.

13. The thirteenth part of the paper discusses the significance of the study and the potential for impact.

14. The fourteenth part of the paper provides a detailed discussion of the acknowledgments and the support received.

15. The fifteenth part of the paper discusses the references and the sources used in the study.

16. The sixteenth part of the paper provides a detailed discussion of the appendices and the additional data.

17. The seventeenth part of the paper discusses the index and the location of the various sections.

18. The eighteenth part of the paper provides a detailed discussion of the bibliography and the list of references.

Project No.	Project Name	Status (See Key)	Notes
2	2--Highway Relocation Study	2	
2	Y--W. Lafayette Shopping Center Study	2	
2	2--Bypass Re-evaluation Studies	2	
2	AA--Sampling for County Needs	2	
5	BB--Highway Performance Evaluation	5	
	<u>Pavement Design</u>		
2	A--General	2	
2	B--Design	2	
3	C--Test Road, Churubusco	3	
3	D--Thickness Design	3	
5	E--Bituminous Concrete	5	
2	F--U. S. 31 Test Road Core	2	
	<u>Bridges</u>		
3	A--Dynamic Forces	3	
2	B--Vibration	2	
3	C--Soil Pressure, U-type Bridge	3	
2	D--Bridge Site Topo Maps, Photogrammetry	2	
3	E--Design of Washers for High Tensile Bolts	3	
2	F--Fatigue Properties	2	
2	G--Fatigue Properties, Light-Weight Concrete	2	
	<u>Cement</u>		
1	A--Slag Cement, Durability of Concrete	1	
	<u>Prestressed Concrete</u>		
2	A--Creep & Shrinkage	2	
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Sp. B.

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11. Terminations under 1.00% 1, 1961, see the "Annual
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isheit, H.

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